Final Report

An Evaluation of Land Use Patterns Versus Estuarine Habitat Quality in South Carolina's Coastal Zone

Prepared for the

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Introduction:

South Carolina's extensive estuarine and coastal waters represent a valuable state resource that must be protected to ensure both the viability of the state's commercial and recreational fishery resources as well as the general health of these ecosystems for recreational use and quality of life for future generations. However, the coastal zone faces increased threats from changes in land use patterns due to the high population growth that has already occurred and will continue to occur as more people move to South Carolina. Between 1990 and 2000, there has been an increase of more than 500,000 people living in the state (SC Budget and Control Board, 2004). Growth in the coastal counties alone is projected to increase from the 2000 census of 574,956 people to 996,680 people by 2025 (SC Budget and Control Board, 2004), which represents a 73% increase in coastal growth. The construction of infrastructure (e.g., roads, commercial development, residential housing, industry) that accompanies human development will alter the rate and volume of freshwater inflow as well as the type and amount of pollutants introduced into estuaries (Fulton *et al.*, 1993; Mallin *et al.*, 2000). Therefore, increased coastal growth has a high potential to seriously impact South Carolina's coastal environment.

This study was initiated in order to evaluate whether there are any clear relationships between coastal development and recent assessments of estuarine coastal condition. Changes in the quality of receiving water bodies in response to changes in land use associated with urbanization have been well documented for freshwater streams (Schuler, 1994; Arnold and Gibbons, 1996), but similar studies are generally lacking in estuarine environments. Sanger *et. al.*, 1999a, 199b; Lerberg *et al.*, 2000; and Holland *et al.* (2004) have documented the effects of land use change on the quality of intertidal creek habitats that represent the headwaters of many estuarine drainage systems. Their studies have shown that when impervious cover exceeds 10-20%, there were measurable alterations in the hydrography, salinity variance, sediment characteristics, contaminant levels, and fecal coliform loadings in these small creeks. When the amount of impervious surface exceeded 20-30%, living resources were affected as well. Because those studies were generally limited to the headwater portions of tidal creeks, it is unclear whether similar effects would be observed in larger tidal creeks or more open estuarine water bodies such as tidal rivers. Other studies in South Carolina have looked at alterations in estuarine habitat quality related to changes in land use patterns (e.g., Fulton *et al.*, 1993; LUCES Study, in progress), but these also have been limited to a few watersheds, and with one exception, have not focused on larger drainage systems.

Since 1999, The South Carolina Department of Natural Resources (SCDNR) and the South Carolina Department of Health and Environmental Control (SCDHEC) have been collecting data on estuarine habitat quality as part of the South Carolina Estuarine and Coastal Assessment Program (SCECAP; Van Dolah *et al*., 2002; in press). SCECAP supplements and compliments numerous ongoing monitoring programs being conducted by the SCDNR and SCDHEC in our coastal habitats and provides a more comprehensive assessment of the overall health of these habitats that may change with increasing coastal development. The sampling methodologies for some components of this program have also been employed in other studies of South Carolina estuarine condition (Hyland *et* *al.,*1996, 1998; Ringwood *et al.*, 1997; Van Dolah *et al.*, 2000, 2004). For the current study, a collective assessment of estuarine habitat quality was based on SCECAP and similar studies in the state in both subtidal tidal creeks and large open water bodies.

Methods:

Thirty 14-digit hydrologic unit code (HUC) watersheds located throughout South Carolina were selected for analysis of land use patterns (Figure 1). These HUCs ranged from watersheds that had a relatively high level of land development to watersheds with very little upland development. Only HUCs that had been sampled in at least one location within the watershed for environmental condition were used for this analysis. Each HUC was clipped from the larger Landsat Thematic Mapping Imagery obtained primarily in 1997/1998 by the USGS Earth Resources Observation Systems (EROS) Data Center. This imagery has a spatial resolution of 30 m and has recently been analyzed by the Water, Land and Conservation Division for land cover patterns (SCDNR, unpublished). The imagery classifications compiled by the SCDNR include open water, emergent wetlands, scrub/shrub wetlands, forested wetlands, scrub/shrub uplands, forested uplands (several categories), cultivated land, grassland/pasture, bare land, high intensity urban, and low intensity urban. Since a high percentage of the estuarine water and sediment quality data now available for assessing the condition of South Carolina's estuaries was obtained through the studies noted above between 1993 and 2002, this new Landsat imagery provides a useful assessment of existing land use patterns that corresponds to the same approximate time period that the environmental data were collected. The 30 HUCs analyzed in this study were clipped by watershed boundaries and analyzed for the various land cover attributes to obtain an estimate of the total hectares and percent of upland habitat representing each land use category.

Based on a preliminary analysis, some land cover categories were combined to simplify the analysis of land use patterns versus environmental condition. These included merging scrub/shrub wetlands with forested wetlands, grassland pasture with scrub/shrub upland, and deciduous forest with mixed forest upland. Scrub/shrub wetland, scrub/shrub upland, and deciduous forest never comprised more than 4, 8 and 4% of total upland cover, respectively, within any HUC and were therefore merged with the most ecologically similar land cover type to reduce the number of categories. The low and high urban land use categories were analyzed both separately and combined.

An analysis of the percent impervious cover within each HUC was obtained by applying a computer-generated triangular grid of points that was overlaid on high resolution color infrared National Aerial Photographic Program (NAPP) imagery taken during the winter of 1999. Each Digital Ortho Quarter Quad (DOQQ) was evaluated at a 1:12,000 scale scanned from a 1:40,000 NAPP image to provide a 1-meter resolution. Points that fell on impervious surfaces were divided by the total number of points that fell on upland categories to estimate the percent of upland in impervious surface. Dependent on the size of the HUC, between 79 and 439 points (average of 198 points) were evaluated to compute percent impervious surface. Estimates of the population within each HUC were also computed using the Census Tiger 2000 data and the Data Partitioner extension in ArcGIS.

To evaluate habitat condition within each HUC, several studies that collected comparable data were collated into one database. As noted previously, the primary data source was from the SCECAP monitoring effort conducted from 1999-2002 (Van Dolah *et al.*, 2002; 2004). A total of 168 stations were located within the boundaries of the 30 HUCs analyzed for land cover patterns. The three other studies conducted by the SCDNR in conjunction with other agencies include baseline assessments of conditions at 11 subtidal sites in Broad Creek on Hilton Head Island and the Okatee River (1997; Van Dolah *et al.*, 2000), 10 subtidal sites in the May River (2002; Van Dolah *et al.*, 2004), and 12 subtidal estuarine sites throughout South Carolina as part of the Carolinian Province Environmental Monitoring and Assessment Program (1993-1995; Hyland *et al.,*1996, 1998; Ringwood *et al.*, 1997). As noted previously, all of these studies used similar sampling protocols, thereby allowing the data to be merged for integrated analyses of sediment quality, some water quality measures, and benthic community condition. Various water quality parameters (DO, pH, TN, TP, fecal coliform, TOC) and a collective measure of sediment contaminant concentrations (ERM-Q; Long *et al.*, 1995) collected at all stations sampled within each HUC were averaged to obtain the best estimate of environmental condition for each parameter. Tidal creek data were treated separately from data from open water sites in compiling the averages for statistical comparisons of environmental condition versus land cover patterns. Benthic condition was not included in this analysis due to the discontinuous nature of the data, but may be considered in further analyses beyond the scope of this agreement.

Statistical analyses of land use and environmental variables were performed using JMP version 5.0.1.2 (SAS Institute, Inc., 2003). A standard pair-wise correlation matrix was generated to analyze relationships between the variables, and the Pearson product-moment correlation for each land-use/environmental pair of variables is listed in Table 1 for both open water and tidal creek sites. Relationships had to be statistically significant at $p \leq 0.10$ (90% probability) to be considered significant within the correlation matrix.

Backwards stepwise regression models were run on selected environmental variables, followed by a standard least squares test, to create a regression equation based on the parameters selected by the regression model (SAS Institute, Inc., 2003). At each step, the backwards stepwise regression model removed a land use variable that did not show a significant relationship with the environmental parameter being analyzed. The remaining significant land use parameters were then included in a standard least squares model, which examined the relationships and calculated a regression line with associated R^2 value. Multicollinearity among variables was assessed using the variance inflation factor (VIF). VIF values for particular variables greater than approximately 5.0 indicate that the coefficient of determination of each independent variable is higher than desirable. When this occurs, variables with high VIF values were eliminated from analysis, and backwards regression models recalculated with the subset of remaining variables. Most analyses conducted had VIF values less than 5.0, indicating that multicollinearity was not a common occurrence in this dataset.

In addition to these statistical analyses, plots of the data were evaluated to determine if there were any clear patterns or thresholds where changes in environmental quality were observed above a particular percentage of land use cover.

A second analysis was also conducted on the combined data set by establishing a buffer around each sampling site. A 1-km radius buffer was used for the tidal creek sites and a 2-km buffer was used for the larger open water sites. This buffer provided the best estimate of land use patterns in proximity to a station without running a high risk of including land that would be located in another watershed. Sites that had no upland within the buffer and those located close to the ocean interface were excluded from the analysis. A number of SCECAP sites that were not included in the HUC analyses were analyzed for this study component (total of 222 stations). The land cover attributes were analyzed within each buffer using the same procedures described for the HUC analysis, except that a percent impervious surface and population estimates within the buffer were not computed. The land use cover estimates were then compared with the environmental data available for each station using the statistical procedures described above. A correlation matrix was generated for both tidal creek and open water stations using the procedures described above. Likewise, backwards stepwise regressions followed by standard least squares test were run to generate a regression model and associated R^2 value for selected environmental variables.

Results and Discussion:

Land Cover Patterns:

A summary of land use patterns for the 30 Hydrologic Unit Code watersheds is provided in Appendices 1 and 2. The 14-digit HUCs ranged in size from 3,006 to 22,674 hectares. Thirteen of the HUCs were less than 10,000 hectares and the remaining 17 were greater than 10,000 hectares. Only one HUC was greater than 20,000 hectares in size. Total upland coverage in the HUCs ranged from 2,033 to 11,653 hectares. Fourteen HUCs had less than 5,000 hectares of uplands, another 14 had between 5,000 and 10,000 hectares of uplands, and the remaining two had more than 12,000 hectares of upland. There was moderate correlation between the total number of upland hectares to total watershed hectares ($R^2 = 0.43$).

The proportion of each watershed that had urban (low and high urban combined) ranged from 0 to 78% (Appendix 2). Thirteen watersheds had less than 10% urban cover, eight watersheds had between 10 and 30% urban cover, and the remaining nine watersheds had greater than 30% urban cover. Bare land, which may represent early stages of development, was generally less than 10% of the upland cover except in one HUC. The proportion of cultivated land ranged from 0 to 13% of the upland cover among the 30 HUCs, but only four HUCs having more than 10% of this land use category. Evergreen forests formed the greatest cover of undeveloped land, ranging from 9 to 80%.

Land cover within the buffer zones surrounding the individual stations is summarized separately for tidal creek stations (Appendix 3,5) and open water stations (Appendix 4,6). All of the tidal creek buffers were approximately 323 hectares in size and the open water buffers were approximately 1,273 hectares in size. Upland cover within the tidal creek buffers ranged from 0 to 77%. Of the 126 sites considered in this study component, 41 stations had less than 10% upland cover within the 1 km radius buffer zone, due primarily to expansive marsh wetlands. Similarly, 27 of the 132 open water stations had less than 10% upland cover, largely due to a high percentage of both water and wetland marsh coverage within the 2-km radius buffer zone. Subsequent analyses planned beyond the scope of this project may exclude these stations to see if correlations with upland characteristics are improved.

Among the 126 tidal creek stations, urban land cover ranged from 0 to 59% of the upland habitat, with ten stations having between 10 to 20% urban cover, seven stations having between 20 to 30% urban cover, and 18 stations having greater than 30% urban cover (Appendix 4). Bare land ranged from 0 to 100%, but only five stations had more than 20% bare land. Cultivated land ranged from 0 to 52%, with only six stations having more than 20% of the upland cover in cultivated land.

Among the 132 open water stations, urban land cover ranged from 0 to 94%, with 16 stations having between 10 to 20% urban cover, 14 stations having between 20 to 30% urban cover, and 32 stations having greater than 30% urban cover (Appendix 6). Bare land ranged from 0 to 68% of the upland cover, with 12 stations having more than 20% bare land. Cultivated land ranged from 0 to 57%, but only four stations having more than 20% cultivated land.

Watershed Land Use Patterns vs Estuarine Habitat Quality

The mean values of each habitat quality variable measured within each of the 30 HUCs are summarized in Appendices 7 and 8 for tidal creek and open water habitat, respectively. Results of the pair-wise correlation analyses of the percent upland land use categories versus mean of the various environmental measures within each HUC are summarized in Table 1. All values highlighted with shading are statistically significant at the $p < 0.1$ level, with orange shading designating correlations ≥ 0.40 and yellow shading designating ≥ 0.30 but < 0.40, and pale yellow shading designating ≥ 0.20 but < 0.30.

<u>Contaminants:</u>

For both tidal creek and open water habitats, there was a significant strong correlation between urban land cover (low, high, combined) and the integrated ERM-Q contaminant measure (Table 1, Figures 2-5). In both cases, there was a stronger correlation between high urban land use and ERM-Q compared to low urban land use and ERM-Q (Table 1), as would be expected. The percent impervious surface and population density in the HUCs also showed a strong positive correlation that was significant in both tidal creek and open water habitats, adding additional support that urban development is resulting in a degradation of estuarine sediment contaminant levels.

Regression analyses provide some insight on when land use coverage may have a high probability of resulting in elevated sediment contaminants in estuarine watersheds (Figures 2-8). However these analyses should be treated with caution and considered as preliminary analyses since relatively few of the HUCs had mean ERM-Q quotients above levels predicted to have probable adverse bioeffects. For example, in our analysis of tidal creek habitats, only two HUCs had mean ERM-Q values in tidal creeks above 0.058, a level shown to have a high probability of observing adverse effects in benthic communities in southeastern estuaries (Hyland *et al*., 1999; Appendix 7). For open water habitats, there were only three HUCs that had mean ERM-Q values above 0.058 (Appendix 8). For both tidal creek and open water sites, ten HUCs had ERM-Q values above 0.02, which indicates a moderate risk of observing degraded benthic communities (Hyland *et al*., 1999). Many of the HUCs with ERM-Q values above 0.02 in tidal creeks occurred when urban cover (both low and high urban density) was well below 10% of the total upland cover. This was also true for the open water habitat assessment. The two HUCs with ERM-Q values exceeding 0.058 in tidal creeks had approximately 70% or more of the upland as urban (either low or high). In comparison, one of the three HUCs with mean ERM-Q values exceeding 0.058 in open water habitats had approximately 10 to 20% urban cover (either low or high) and between 20 to 30% total urban cover.

Regression analyses of ERM-Q values in tidal creek sediments versus the percent of upland in urban development also showed evidence that increased coastal development results in higher contaminant levels. Using a third order polynomial regression, there appears to be a moderate to good correlation ($R^2 > 0.5$ to 0.8) of observed sediment ERM-Q contaminant levels above 0.058 in tidal creeks when low density urban development exceeds approximately 45% of the land cover, high density urban development exceeded about 15% land cover and all urban cover combined exceeded about 65% land cover (Figure 2). An evaluation of percent impervious surface and population density within the HUC showed even stronger correlations ($R^2 > 0.9$), with ERM-Q values exceeding 0.058 when impervious surfaces exceeded about 5 to 35% and population densities exceeded about 50,000 (Figure 3). When linear regressions were used, the correlations were lower ($R^2 > 0.2$ to 0.3) and estimated ERM-Q values exceeded 0.058 when low density urban development exceeded about 30 to 40%, high density urban development exceeded 10 to 15%, and total urban development exceeded approximately 50% (Figure 4). Linear regressions of percent impervious surface and population were a bit higher ($R^2 > 0.4$), with ERM-Q values exceeding 0.058 when impervious cover exceeded 30% and population exceeded about 40,000 (Figure 5).

When evaluating open water habitats, similar patterns were observed (Figures 6-9). Based on the polynomial regressions, ERM-Q values exceeded 0.058 when low density urban development exceeded 30 to 40%, high density urban development exceeded 10 to 15%, and total urban development exceeded 60 to 70% ($R^2 > 0.2$ to 0.9, Figure 6). As noted for tidal creek habitats, correlations between both percent impervious surface and population were relatively high ($R^2 > 0.7$ to 0.8), with high ERM-Q values observed when percent impervious cover exceeded about 30% and population density exceeded about 50,000 (Figure 7). Linear regressions showed similar patterns, but with lower correlation coefficients ($R^2 > 0.2$ to 0.6 for urban categories, and 0.3 to 0.5 for impervious surface and population comparisons, Figures 8,9)

Backwards stepwise regression analysis comparing ERM-Q values with all land categories (except urban combined) identified a model with high urban development explaining about 63% of the variance in open water habitats with a high level of statistical significance ($R^2 = 0.634$, $p < 0.0001$). In tidal creek habitats, only one variable, population, accounted for about 43% of the total variance in the model ($R^2 = 0.437$, $p < 0.0004$). Forcing other land use variables into the model did not significantly improve either model.

The relatively similar results between tidal creek and open water habitats was surprising since one would expect greater effects to be observed in tidal creeks versus the larger open water habitats since tidal creeks are both closer to the source of contaminant input and have less flushing capacity. Future analyses may include lumping these habitat types to maximize the number of stations that the environmental parameter means are derived from.

<u>Other Sediment Variables</u>:

The pairwise comparisons of other sediment variables showed only a few significant relationships with some land use variables. Sediment TOC, which has been shown to be indicative of anthropogenic stress (Hyland *et al*., 2000), was negatively correlated to the percentage of land cover as grassland/pasture + scrub/shrub, and for bare land when evaluated for tidal creek habitats (Table 1). There was also a significant positive relationship in TOC with population density. TOC did not show any significant relationships with open water habitats.

Silt/clay concentrations were negatively correlated with grassland/pasture + scrub/shrub land cover and bare land for tidal creek habitats and positively correlated with high urban development in open water habitats (Table 1). Holland *et al*. (2004) noted that urban creeks were generally sandier than undeveloped creeks. Our analyses did not show similar patterns, which may be due to the limited data available or due to the fact that we only sampled larger tidal creeks and open water habitats.

<u>Water Quality Variables</u>:

The pairwise correlation analyses showed strong correlations for some of the water quality variables, but the patterns were not as consistent as those noted for sediment contaminants. Additionally, some of the relationships, although statistically significant, did not show strong relationships when evaluated using regression analyses.

For example, dissolved oxygen (DO) showed strong negative correlations with evergreen forest cover and strong positive correlations with urban land use variables, including the percent impervious surface and population density in open water habitats, but not in tidal creek habitats. There is no obvious explanation for the positive relationships noted for open water habitats. While the Pearson product moment correlations were significant, regression analyses indicated that mean DO values in the open water habitats were generally good in all of the HUCs evaluated, ranging from about 4 – 6 ppm (Figure 10).

Levels of pH also showed significant correlations with several of the land use variables. The most consistent relationship was a negative correlation between the percent of land cover in evergreen forest and pH for both tidal creek and open water habitats (Table 1). This would be expected due to the acidic nature of this land cover. The percent cover of bare land was also positively correlated with pH for both habitat types. Other significantly positive relationships were found for open water habitats with respect to pH and urban cover (low and combined only) and population density. As with DO, regression analysis of pH with these land use variables did not show a large difference in pH with change in land cover, and the most limiting pH values (<7.4) were generally associated with HUCs having the lowest development.

Salinity showed positive correlations with a few land use variables, but no clear patterns that are likely related to the urbanization of estuarine watersheds. The strongest relationship observed was a significant negative correlation in salinity with high urban development (Table 1). This is likely due to the fact that many urban watersheds are located in the portions of the estuaries that are located further inland, where salinities would be lower. Future analyses may also evaluate salinity variance since Holland *et al*. (2004) noted that this variable was related to urban development in the headwater portions of tidal creeks. However, since most of the data were collected during a 4-yr drought period, this relationship may not be apparent even if it would occur in normal or wet years.

Water TOC, BOD and total nitrogen showed very few significant relationships with the land use patterns measured (Table 1). Total phosphorus, on the other hand, showed a significant positive relationship with urban development (combined), percent impervious surface and population density in tidal creek habitats, but not in open water habitats. When a backwards stepwise regression was conducted on TP versus the land use variables in tidal creek habitats, population density was the only variable remaining in the model, with that variable explaining approximately 20% of the variance ($R^2 = 0.206$, $p = 0.026$). Chlorophyll-a concentrations were negatively correlated with grassland/pasture + scrub/shrub, deciduous forest + mixed forest, and cultivated land for open water habitats only. Fecal coliform bacteria concentrations were significantly positively correlated with low density urban development for both tidal creek and open water habitats, but not for high density or combined urban development. Low density urban development would be expected to have a higher percentage of waste from septic systems, domestic pet waste, and wildlife waste than high density urban development, which may partially explain this pattern. The percent of low urban development was also the only upland variable in the backwards stepwise regression model for fecal coliform bacteria, although the relationship and statistical probability of this model was not high ($R^2 = 0.112$, $p = 0.08$).

Station Land Use Patterns vs. Estuarine Habitat Quality

In general, the relationships between land cover within the buffer areas surrounding each station and estuarine environmental quality variables were not as strong as those noted for the watershed analysis at the 14-digit HUC level, with the exception of some of the comparisons of ERM-Q and urban land use categories (Table 1). Due to the lack of time available to complete this initial study of land use patterns within the project time frame, the percent impervious surface for each of the 258 stations analyzed could not be completed. It is also not possible to estimate population density within these buffer areas. Therefore, these two land use variables were not included in the Pearson product moment pairwise comparisons.

Contaminants:

As observed in the watershed analysis, there was a significant positive correlation between ERM-Q values and the percent of land cover in urban development (low, high, and combined) with a higher correlation coefficient between high density urban development than low density urban development (Table 1). Compared with the HUC analysis, the station analyses generally had lower Pearson product moment correlations than those observed in the HUC analysis, with the exception of high density urban development and ERM-Q values.

Regression analysis of the station buffer datasets with ERM-Q also showed similar results compared to the HUC analyses, but the R^2 values of the regressions were lower for some of the urban land cover attributes, especially the percent of low urban development (Figures 11-14), which did not provide good predictive estimates of when low density urban cover would result in high ERM-Q values using either a third order polynomial analysis or a linear regression analysis. In contrast, the relationship between the percent of land that was high density urban development or combined urban development had a much stronger relationship in both habitats using the polynomial regression (Figures 11,12) than observed using the linear regression (Figures 6,8). For tidal creek stations, both the polynomial and linear regression indicated that ERM-Q values would exceed 0.058 when high density urban development exceeds 20 to 30 percent of upland cover (Figure 11, 13). Neither of the tidal creek regression analyses for combined urban cover were predictive for ERM-Q values above 0.058. For open water stations, the polynomial regression indicated that ERM-Q values would exceed this threshold when high density urban development exceeds 20 to 30% of the land cover (Figure 12) and the linear regression indicated that this would occur when high density urban development exceeds 10 to 20% (Figure 12, 14). When combined urban development was analyzed, the thresholds in land cover to exceed an ERM-Q value of 0.058 were between 60 to 80% and 40 to 60% for the polynomial and linear regression respectively (Figures 12, 14).

The backwards stepwise regression analysis of the station buffer database comparing ERM-Q values with all land categories (except urban combined) was not as informative as the models generated at the HUC level. In open water habitats, high urban development was the only land use parameter that did not remain in the model for ERM-

Q values. While the remaining variables (scrub/shrub wetland + forested wetland, bare land, grassland/pasture + scrub/shrub, deciduous forest + mixed forest, evergreen forest, cultivated land, and low urban development) explained approximately 60% of the variance ($R^2 = 0.603$, $p < 0.001$), the model did not provide insight on the effects of particular land use categories and sediment quality. In tidal creek habitats, evergreen forest, low urban development, and high urban development explained 41% of the total variance in the model ($R^2 = 0.414$, $p < 0.07$). Forcing other land use variables into or out of the model did not significantly improve either model.

As more data becomes available, the models generated in both tidal creek and open water habitats may become clearer, with a larger amount of the variance being explained by fewer land use variables. On the short term, combining tidal creek and open water datasets at the station level may prove beneficial to increase sample size and obtain a better understanding of relationships among environmental and land use variables.

Other Sediment Variables:

Correlation coefficients for other sediment variables were generally weaker than the relationships seen between land use and ERM-Q (Table 1). Pairwise comparisons showed only a few significant relationships with some land use variables. Silt/clay content of sediments and sediment TOC, which are strongly correlated with ERM-Q, followed the same general pattern of relationships with land use variables that were observed for ERM-Q in open water habitats (Table 1), although the correlation coefficients were weaker. In tidal creek habitats, only very weak relationships (≥ 0.20 and < 0.30) were found between land use variables versus sediment TOC and silt/clay.

Water Quality Variables:

Pairwise correlation analyses for water quality variables were consistently weaker than those found between ERM-Q and other sediment quality variables. Relationships at the station level were also much weaker than those observed in HUC level analyses. Additionally, some of the relationships, although statistically significant, did not show strong relationships when evaluated using regression analyses, with R^2 values generally less than 0.10.

Dissolved oxygen (DO) showed weak negative correlations with evergreen forest cover and weak positive correlations with high and combined urban land use variables in open water habitats, but not in tidal creek habitats. These were the same general trends observed in HUC level analyses, although correlation coefficients were much weaker in station level analyses. As noted above, there is no obvious explanation for the positive relationships between DO and urban land use in open water habitats. Regression analysis of DO values with high and combined urban land use in open water habitats did not show a large difference in DO with change in land cover ($R^2 < 0.05$).

Levels of pH also showed significant correlations with land use variables (Table 1). The percent cover of bare land was positively correlated with pH in both habitat types, and a negative correlation was found between the percent cover of deciduous forest + mixed forest and pH in open water habitats. Significantly positive relationships were found for open water habitats with respect to pH and urban cover (low and combined only) and population density.

Salinity, water TOC, chlorophyll-a, and BOD did not result in a large number of significant relationships with land use variables (Table 1). However, with respect to total phosphorus, a patters similar to that observed at the HUC level analysis emerged at the station level. Total phosphorus showed a significant positive relationship with high and combined urban development in tidal creek habitats, but not in open water habitats. Linear regression models on TP against high and combined urban development resulted in weak relationships ($R^2 < 0.06$). A backwards stepwise regression on TP versus land use variables for tidal creek stations resulted in a model with only one variable, high urban development ($R^2 = 0.054$, $p = 0.009$). Concentrations of fecal coliform bacteria were significantly positively correlated with low, high, and combined urban development for tidal creek habitats, but not open water habitats (Table 1). Regression analysis of fecal coliform concentrations and low, high, and combined urban development showed only weak trends in fecal coliform concentrations with change in land cover ($R^2 < 0.13$). The percent of high urban development was also the only upland variable that remained in the backwards stepwise regression model for fecal coliform bacteria, although the strength of this relationship was not high ($R^2 = 0.129$, $p < 0.0001$). These results differ from findings in tidal creek habitats at the HUC level, where the strongest relationships with fecal coliform concentrations were found with low density urban development. This variable should be analyzed in more detail in future studies to better understand trends at the HUC and station level.

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References:

Fulton, M.H., G.I. Scott, A. Fortner, T.F. Bidleman, and B. Ngabe. 1993. The effects of urbanization on small high salinity estuaries of the southeastern United States. Archives of Environmental Contamination and Toxicology 25: 476-484.

Holland, A.F., D.M. Sanger, C.P. Gawle, S.B. Lerberg, M.S. Santiago, G. H.M. Riekerk, L.E. Zimmerman, G.I. Scott. (2004). Linkages between tidal creek ecosystems and the landscape and demographic attributes of their watersheds. J. Exp. Mar. Biol. & Ecol. 298:151-178

Hyland, J.L., T.J. Herrlinger, T.R. Snoots, A.H. Ringwood, R.F. Van Dolah, C.T. Hackney, G.A. Nelson, J.S. Rosen, and S.A. Kokkinakis. 1996. Environmental quality of estuaries of the Carolinian Province: 1994. Annual statistical summary for the 1994 EMAP-Estuaries Demonstration Project in the Carolinian Province. NOAA Technical Memorandum NOS ORCA 97. NOAA/NOS, Office of Ocean Resources Conservation and Assessment, Silver Spring, MD. 102p.

Hyland, J.L., L. Balthis, C.T. Hackney, G. McRae, A.H. Ringwood, T.R. Snoots, R.F. Van Dolah, and T.L. Wade. 1998. Environmental quality of estuaries of the Carolinian Province: 1995. Annual statistical summary for the 1995 EMAP Estuaries Demonstration Project in the Carolinian Province. NOAA Technical Memorandum NOS ORCA 123 NOAA/NOS, Office of Ocean Resources Conservation and Assessment, Silver Spring, M.D. 143p.

Hyland, J.L. R.F. Van Dolah, and T.R. Snoots. 1999. Predicting stress in benthic communities of southeastern U.S. estuaries in relation to chemical contamination of sediments. Environmental Toxicology and Chemistry 18(11): 2557-2564

Hyland J., Karakassis, I., Magni, P, Petrov, A. Shine J. 2000. Summary Report: Results of initial planning meeting of the United Nations Educational, Scientific and Cultural Organization (UNESCO) Benthic Indicator Group. 70p.

Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environmental Management 19(1):81-97.

Mallin, M.A., K.E. Williams, E.C. Esham and R.P. Lowe. 2000. Effect of human development on bacteriological water quality in coastal watersheds. Ecological Applications 10:1047-1056.

Ringwood, A.H., R.F. Van Dolah, A.F. Holland, M.E. DeLorenzo, C. Keppler, P. Maier, J. Jones, M. Armstrong-Taylor. 1997. Year two demonstration project studies conducted in the Carolinian Province by Marine Resources Research Institute: Results and Summaries. Final Report submitted to the NOAA/EMAP Carolinian Province Office, Charleston, SC. 154p plus appendices.

Sanger, D.M., A.F. Holland, and G.I. Scott. 1999a. Tidal creek and salt marsh sediments in South Carolina Coastal Estuaries. I. Distribution of trace metals. Archives of Environmental Contamination and Toxicology 37:445-457

Sanger, D.M., A.F. Holland, and G.I. Scott. 1999b. Tidal creek and salt marsh sediments in South Carolina Coastal estuaries. II. Distribution of organic contaminants. Archives of Environmental Contamination and Toxicology 37:458-471.

SAS Institute, Inc. 2003. JMP Statistical Software. Version 5.0.1.2.

South Carolina Budget and Control Board. 2004. South Carolina Statistical Abstract 2003. Prepared by the Office of Research and Statistics 1919 Blanding St. Columbia, SC 29201. Available online at www.ors2.state.sc.us/abstract/index.asp.

Van Dolah, R.F., D.E. Chestnut and G.I. Scott. 2000. A baseline assessment of environmental and biological conditions in Broad Creek and the Okatee River, Beaufort County, South Carolina. Final Report to the Beaufort County Council, 281 p.

Van Dolah, R.F., D.M. Sanger, A. B. Filipowicz (eds). 2004. A baseline assessment of environmental and biological condition in the May River, Beaufort County, South Carolina. A Final Report submitted to the Town of Bluffton, SC. Produced by the South Carolina Department of Natural Resources, the United States Geological Survey, and the National Oceanic and Atmospheric Administration, National Ocean Service. 226 p

Van Dolah, R.F., P.C. Jutte, G.H.M. Riekerk, M.V. Levisen, L.E. Zimmerman, J.D. Jones, A.J. Lewitus, D.E. Chestnut, W. McDermott, D. Bearden, G.I. Scott, M.H. Fulton. 2002. The Condition of South Carolina's Estuarine and Coastal Habitats During 1999-2000: Technical Report. Charleston, SC: South Carolina Marine Resources Division. Technical Report No. 90. 132 p + appendices.

Van Dolah, R.F. D.E. Chestnut, J.D. Jones, P.C. Jutte, G. Riekerk, M. Levisen, and W. McDermott. 2003. The importance of considering spatial attributes in evaluating estuarine habitat condition: The South Carolina experience. Environmental Monitoring and Assessment 81:85-95.

World Travel and Tourism Council. 2001. South Carolina. The Impact of Travel and Tourism on Jobs and the Economy. 1-2 Queen Victoria Terrace. Sovereign Court. London. E1W 3HA. United Kingdom. 44p.

Table 1. Correlation matrix for land-use variables versus environmental variables. Highlighted cells indicate statistically significant correlations ($p \leq 0.10$) where pale yellow ≥ (+/-) 0.20, yellow ≥ (+/-) 0.30, and orange ≥ (+/-) 0.40.

HUC-- Open	DO	pH	Salinity	Water TOC	BOD	Total N	Total P	Chlorophyll a	Fecal Coliform	Silt/clay	Sed TOC	ERMQ
scrub/shrub wetland + forested wetland	-0.17	-0.20	-0.11	-0.08	-0.06	0.19	-0.18	0.00	-0.20	0.16	0.24	-0.13
bare land	0.14	0.35	0.39	-0.07	0.36	-0.36	0.16	-0.13	-0.05	-0.22	-0.24	-0.24
grassland/pasture + scrub/shrub	-0.15	-0.26	0.04	-0.04	0.00	0.32	-0.10	-0.35	0.07	0.03	0.05	-0.25
deciduous forest + mixed forest	-0.32	-0.18	0.31	-0.26	-0.01	0.08	-0.09	-0.32	-0.27	-0.13	-0.09	-0.24
evergreen forest	-0.50	-0.34	-0.07	-0.02	0.01	0.16	-0.15	0.31	-0.21	-0.24	-0.03	-0.55
cultivated land	-0.28	0.02	0.39	-0.36	0.02	-0.14	0.03	-0.33	-0.28	-0.08	-0.09	-0.21
urban (low)	0.55	0.38	-0.03	0.24	-0.06	-0.24	0.17	-0.07	0.34	0.09	-0.07	0.46
urban (high)	0.45	0.22	-0.25	0.02	-0.01	-0.02	0.11	0.05	0.19	0.42	0.23	0.80
urban (combined)	0.55	0.35	-0.12	0.17	-0.05	-0.17	0.16	-0.02	0.30	0.24	0.05	0.64
% impervious	0.50	0.28	-0.17	0.12	-0.06	-0.05	0.17	0.07	0.26	0.28	0.11	0.71
Population (2000)	0.59	0.44	0.12	-0.02	-0.02	-0.29	0.07	0.07	0.08	0.09	-0.10	0.59

HUC-- Tidal	DO	pH	Salinity	Water TOC	BOD	Total N	Total P	Chlorophyll a	Fecal Coliform	Silt/clay	Sed TOC	ERMQ
scrub/shrub wetland + forested wetland	-0.05	-0.32	-0.05	0.03	-0.45	0.24	-0.11	-0.14	0.00	0.11	0.03	-0.10
bare land	0.28	0.52	0.45	-0.38	0.23	-0.24	-0.15	-0.23	-0.20	-0.40	-0.36	-0.27
grassland/pasture + scrub/shrub	0.36	-0.08	0.22	-0.05	-0.10	0.00	-0.19	0.30	-0.36	-0.39	-0.44	-0.45
deciduous forest + mixed forest	0.22	-0.23	0.19	0.09	-0.33	0.24	0.02	0.31	-0.18	-0.13	-0.16	-0.20
evergreen forest	-0.01	-0.39	0.15	-0.13	-0.11	0.17	-0.33	-0.18	-0.12	0.12	-0.07	-0.41
cultivated land	-0.04	-0.05	0.16	-0.26	-0.01	0.20	-0.09	0.15	-0.13	-0.06	-0.13	-0.20
urban (low)	-0.20	0.34	-0.16	0.28	0.27	-0.23	0.32	0.11	0.36	0.04	0.20	0.49
urban (high)	-0.06	0.21	-0.50	0.09	0.01	-0.11	0.33	-0.04	0.05	0.14	0.33	0.55
urban (combined)	-0.15	0.32	-0.32	0.22	0.18	-0.20	0.35	0.05	0.26	0.09	0.27	0.56
% impervious	-0.11	0.30	-0.39	0.12	0.23	-0.08	0.42	0.04	0.25	0.08	0.30	0.60
Population (2000)	-0.19	0.21	-0.29	0.06	0.13	-0.01	0.45	0.09	0.11	0.18	0.39	0.66

Station-- Open	DO	pH	Salinity	Water TOC	BOD	Total N	Total P	Chlorophyll a	Fecal Coliform	Silt/clay	Sed TOC	ERMQ
Scrub/Shrub Wetland + Forested Wetlan	0.10	0.01	-0.17	-0.09	0.05	-0.04	-0.10	-0.01	0.00	0.04	0.03	-0.10
Bare Land	0.10	0.23	0.26	-0.13	0.04	-0.18	-0.07	-0.10	-0.08	-0.21	-0.20	-0.14
Grassland/Pasture + Scrub/Shrub	-0.08	-0.11	0.02	-0.11	0.04	0.14	-0.03	-0.02	-0.04	-0.13	-0.12	-0.24
Deciduous Forest + Mixed Forest	-0.11	-0.30	-0.11	-0.06	0.16	0.29	0.06	0.06	0.04	-0.04	-0.02	-0.17
Evergreen Forest	-0.24	-0.12	0.11	0.05	-0.08	0.00	0.00	-0.01	-0.02	-0.21	-0.16	-0.33
Cultivated Land	-0.07	-0.03	0.01	-0.06	-0.01	0.15	0.03	-0.03	-0.04	-0.03	0.01	-0.06
Urban (low)	0.15	0.17	0.03	0.24	-0.03	-0.11	0.11	0.07	0.10	0.17	0.12	0.35
Urban (high)	0.21	0.03	-0.25	0.01	0.00	0.01	0.03	0.05	0.01	0.48	0.40	0.76
Urban (combined)	0.20	0.12	-0.11	0.15	-0.02	-0.06	0.08	0.06	0.07	0.35	0.28	0.60

Station-- Tidal	DO	pH	Salinity	Water TOC	BOD	Total N	Total P	Chlorophyll a	Fecal Coliform	Silt/clay	Sed TOC	ERMQ
Scrub/Shrub Wetland + Forested Wetlan	0.04	-0.10	0.00	-0.06	-0.14	-0.16	-0.11	-0.16	-0.08	0.26	0.25	0.07
Bare Land	0.17	0.25	0.17	-0.14	-0.04	-0.16	-0.05	-0.08	-0.05	0.03	-0.03	-0.04
Grassland/Pasture + Scrub/Shrub	0.07	0.07	-0.01	0.04	-0.03	0.05	-0.01	0.09	-0.07	-0.16	-0.15	-0.07
Deciduous Forest + Mixed Forest	0.03	-0.03	-0.08	0.15	-0.03	0.15	0.11	0.14	-0.05	-0.09	-0.06	-0.01
Evergreen Forest	0.01	-0.17	-0.07	0.09	-0.02	0.11	0.02	0.02	-0.03	-0.25	-0.23	-0.21
Cultivated Land	-0.04	-0.01	0.05	-0.07	0.09	0.15	0.00	0.21	-0.06	-0.08	-0.10	-0.08
Urban (low)	-0.06	0.15	-0.10	0.11	0.21	-0.01	0.16	0.02	0.31	-0.02	-0.01	0.14
Urban (high)	0.00	0.13	-0.29	0.10	0.05	0.01	0.23	-0.06	0.36	0.16	0.29	0.58
Urban (combined)	-0.04	0.16	-0.17	0.12	0.18	-0.01	0.20	0.00	0.35	0.03	0.09	0.30

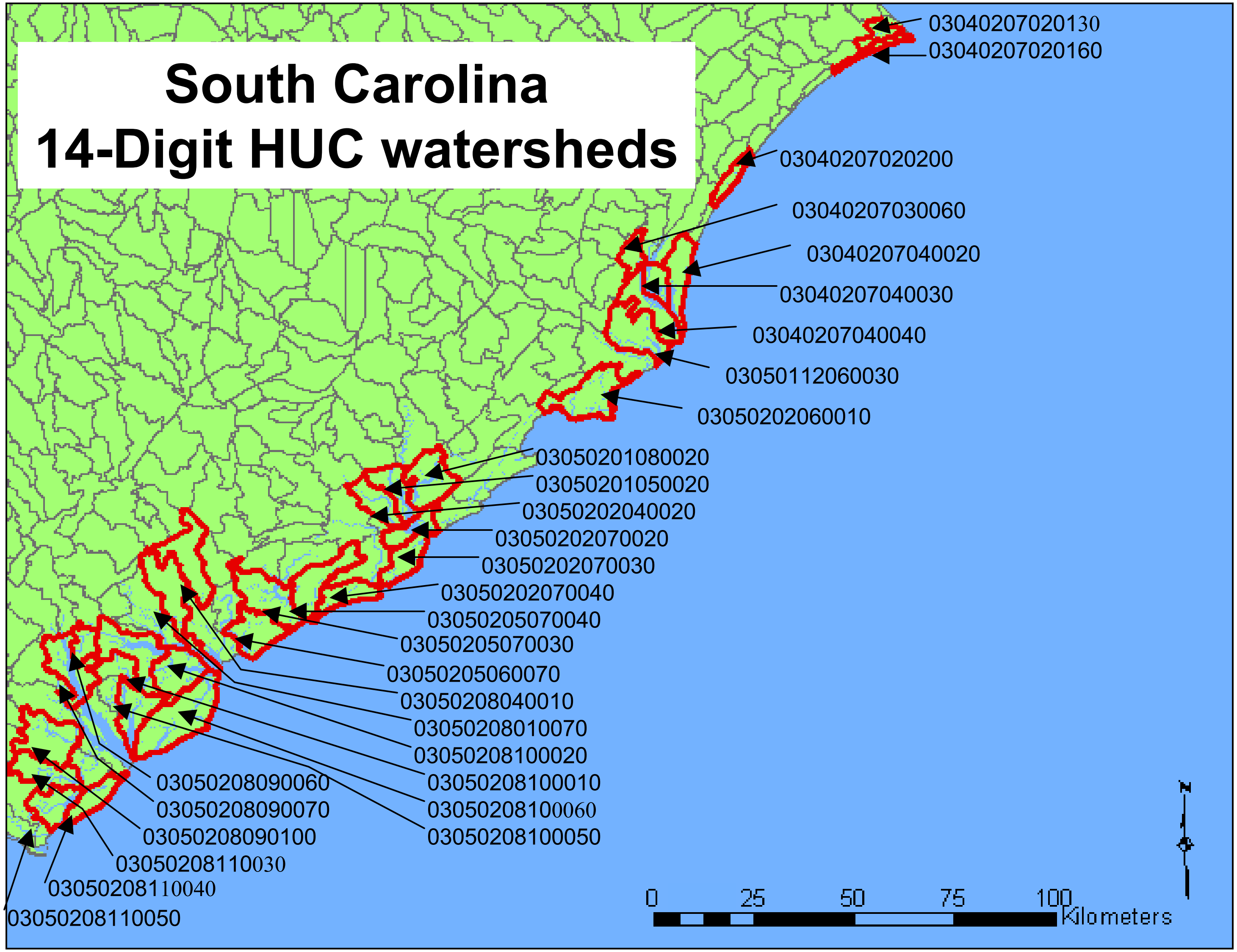


Figure 1. The thirty 14-digit hydrologic unit code (HUC) watersheds located throughout South Carolina that were selected for the current study analyzing land use patterns.

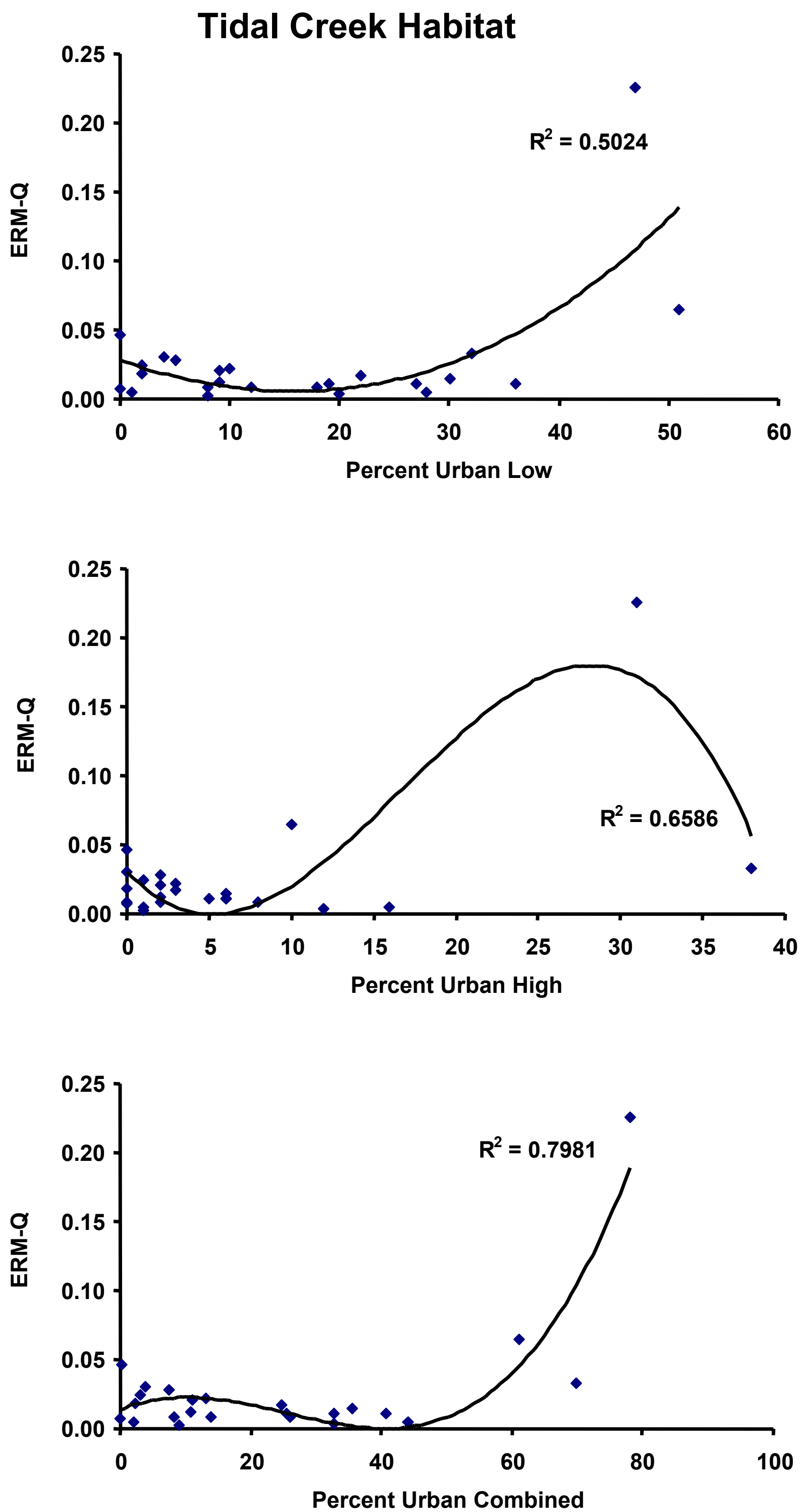


Figure 2. Third order polynomial regressions of ERM-Q versus various levels of urban cover for tidal creek stations at HUC level.

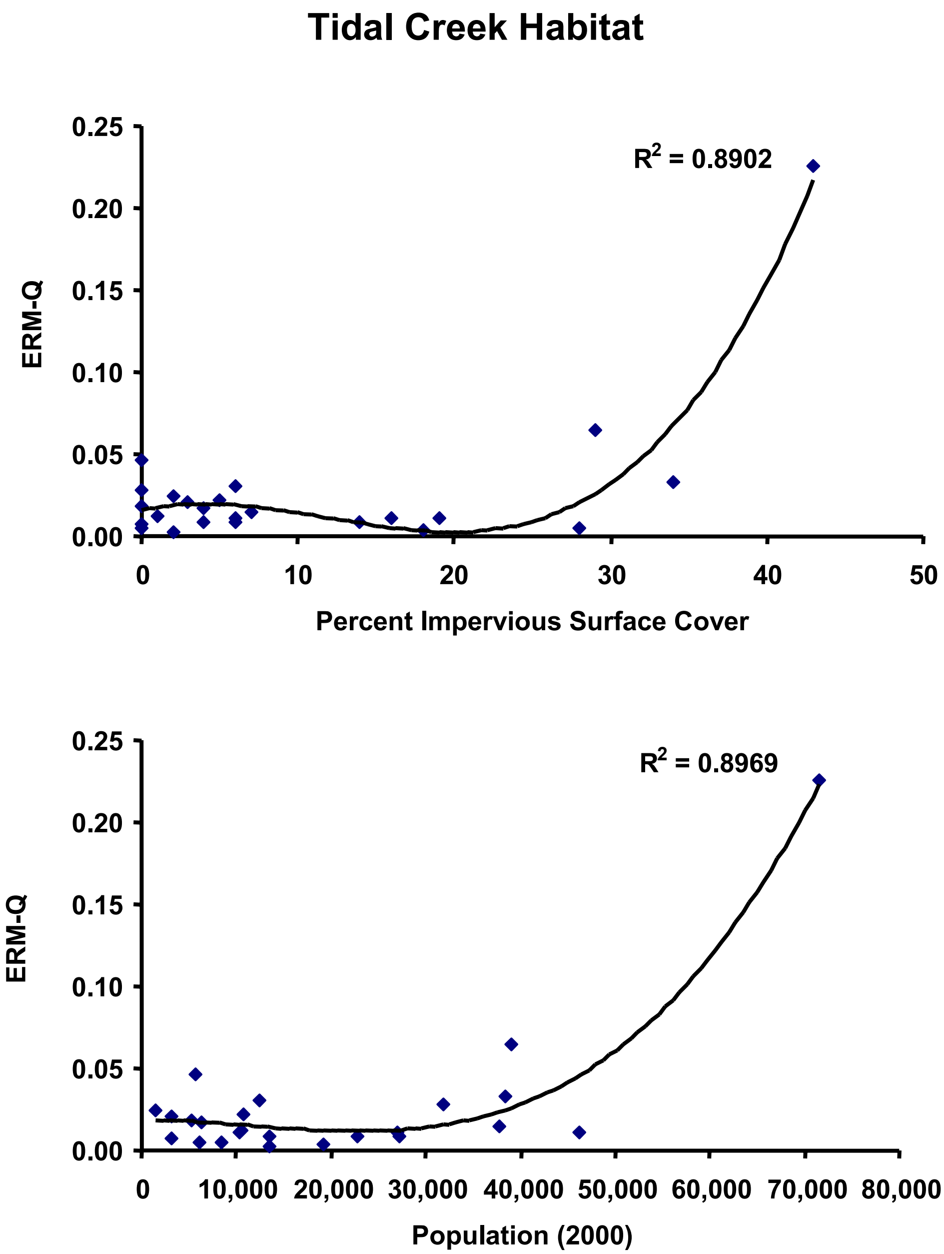


Figure 3. Third order polynomial regressions of ERM-Q versus percent impervious surface cover and year 2000 population for tidal creek stations at HUC level.

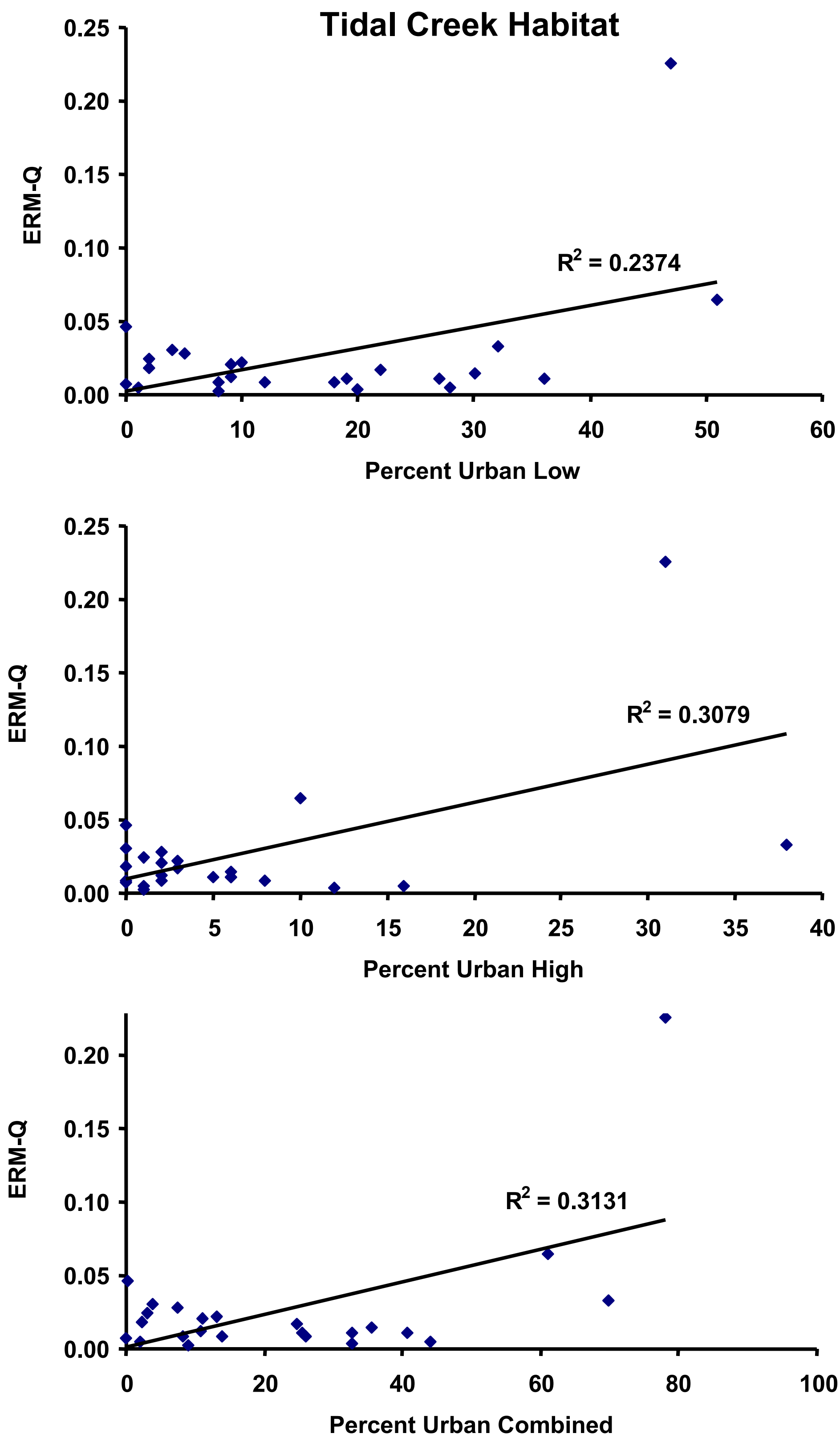
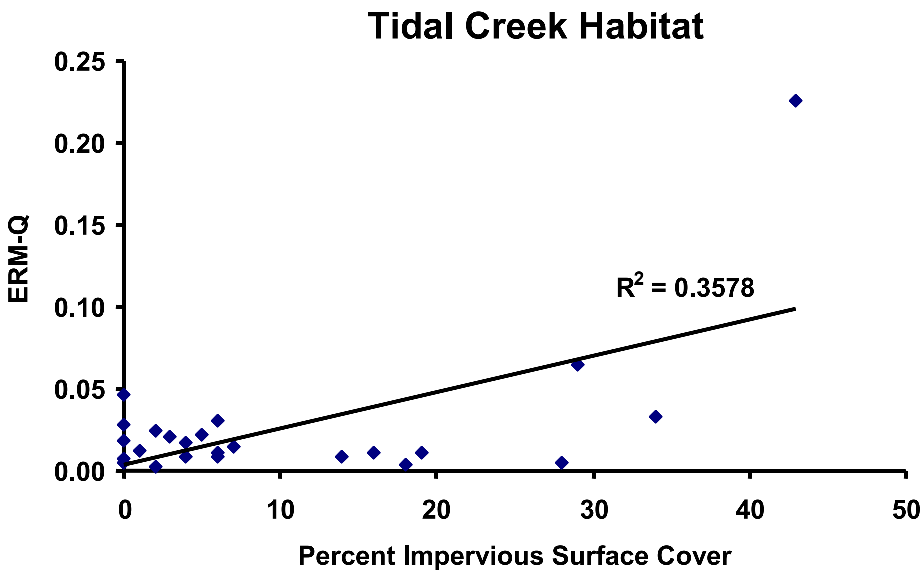


Figure 4. Linear regressions of ERM-Q versus various levels of urban cover for tidal creek stations at HUC level.



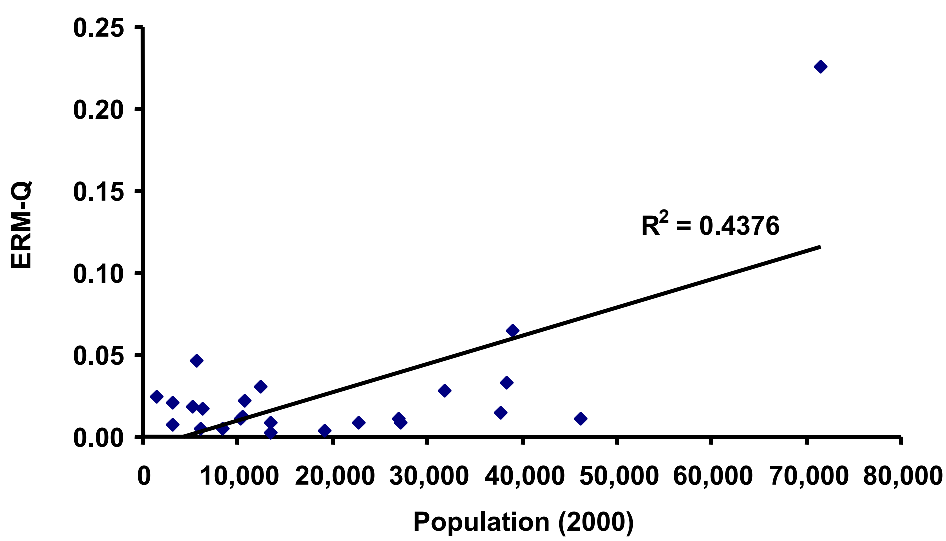


Figure 5. Linear regressions of ERM-Q versus impervious surface cover and year 2000 population for tidal creek stations at HUC level.

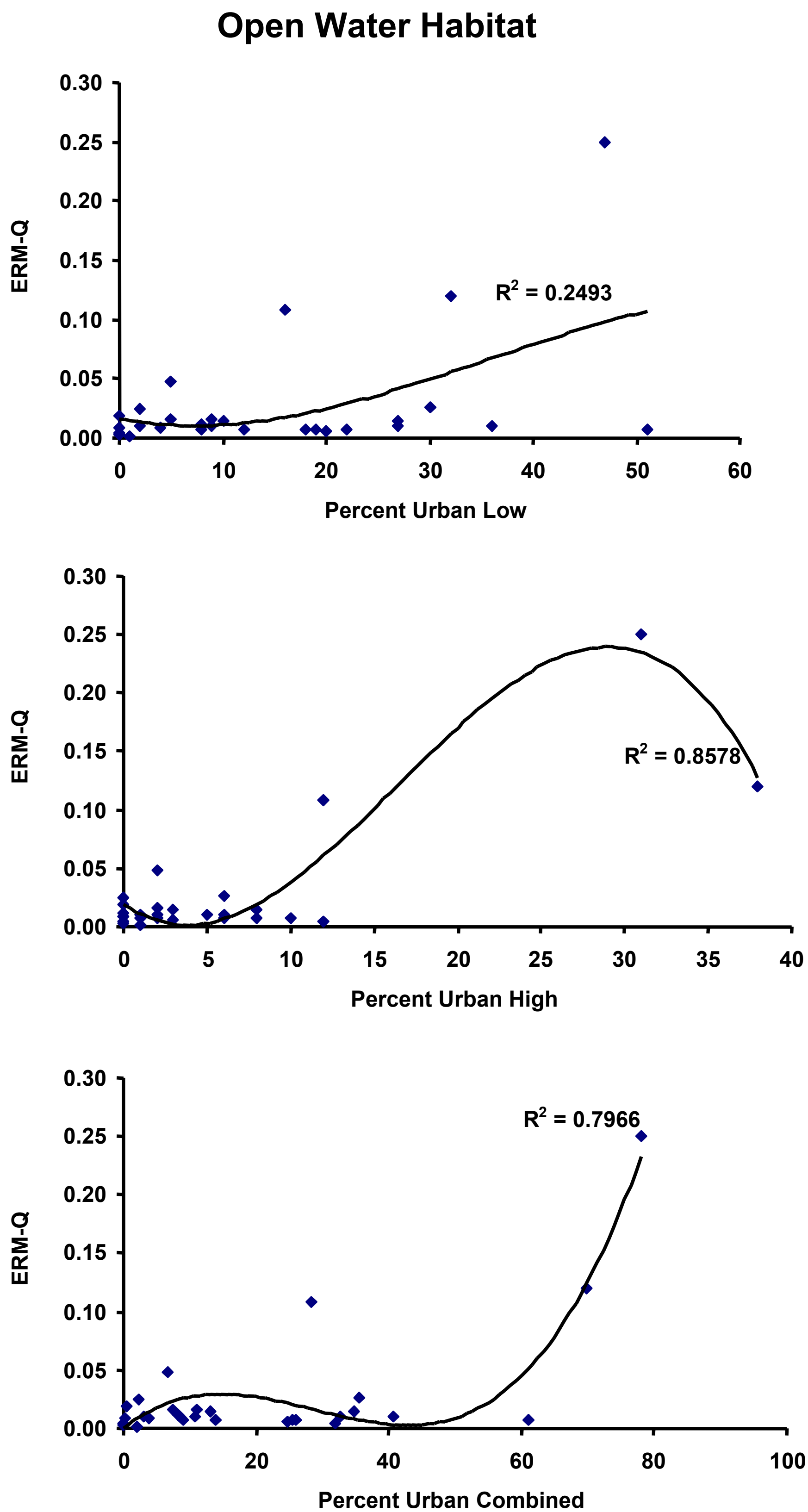
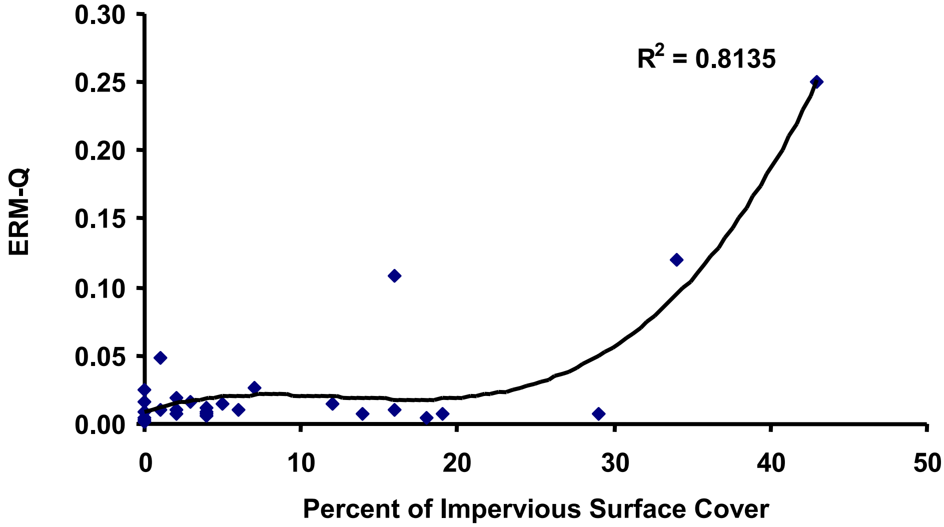


Figure 6. Third order polynomial regressions of ERM-Q versus various levels of urban cover for open water stations at HUC level.

Open Water Habitat



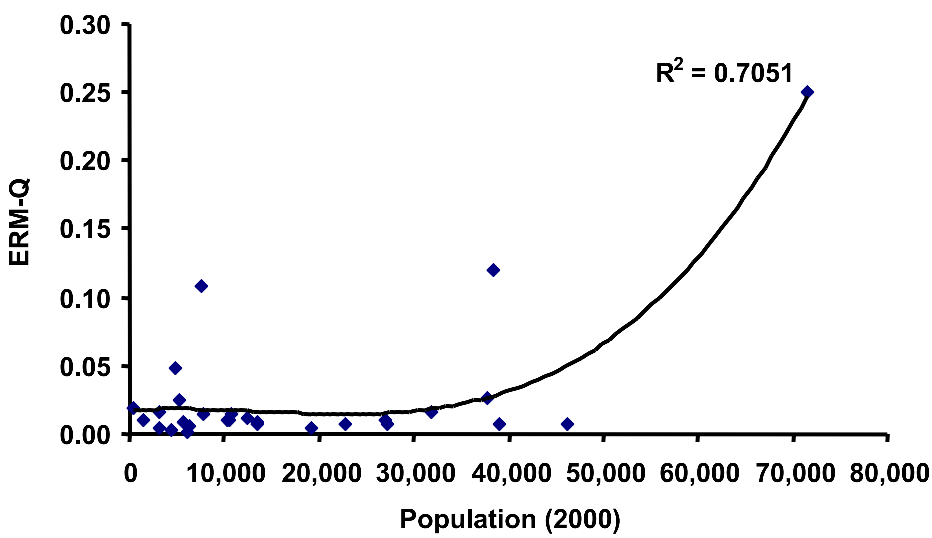


Figure 7. Third order polynomial regressions of ERM-Q versus percent impervious surface cover and year 2000 population for open water stations at HUC level.

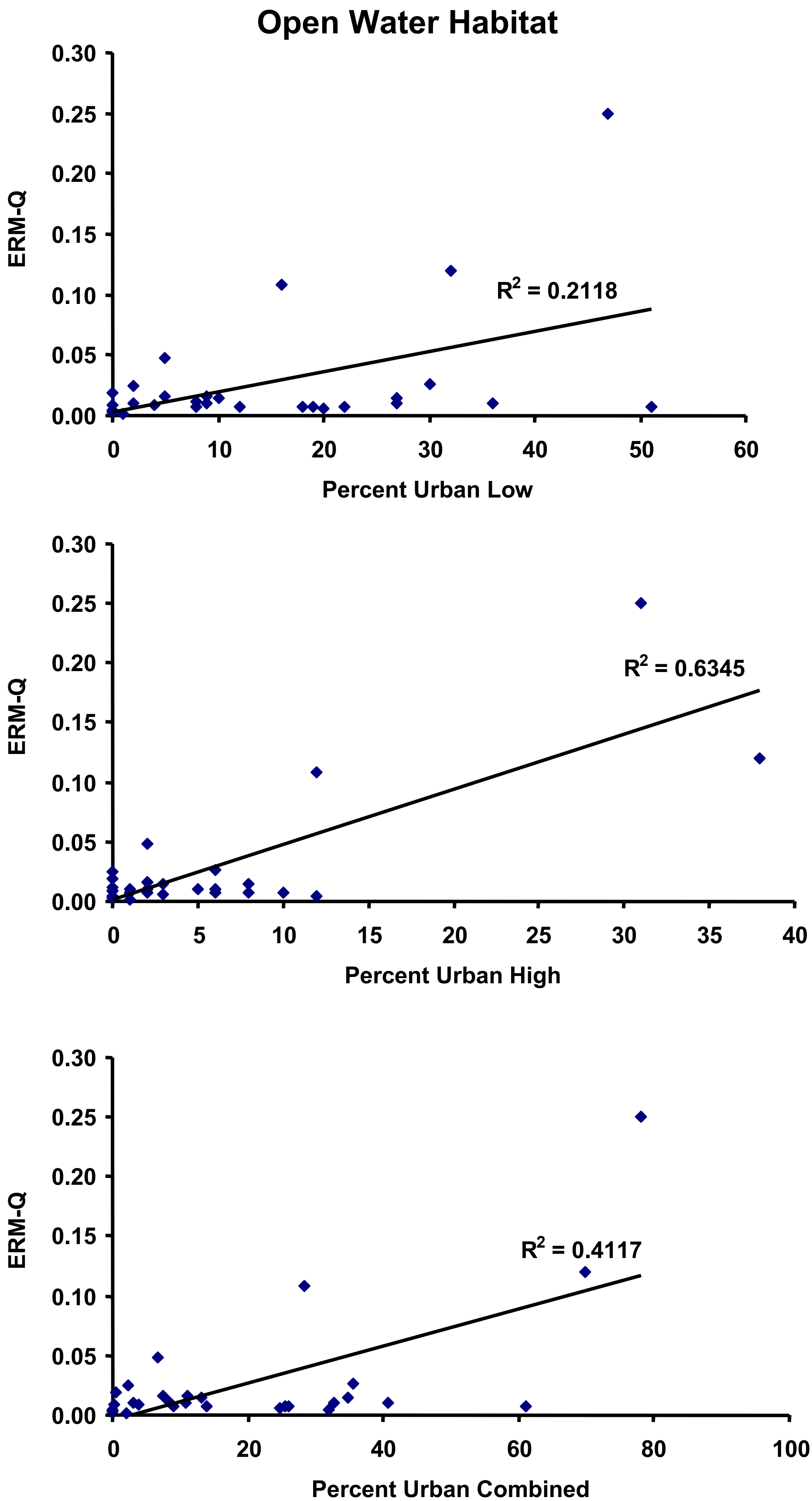
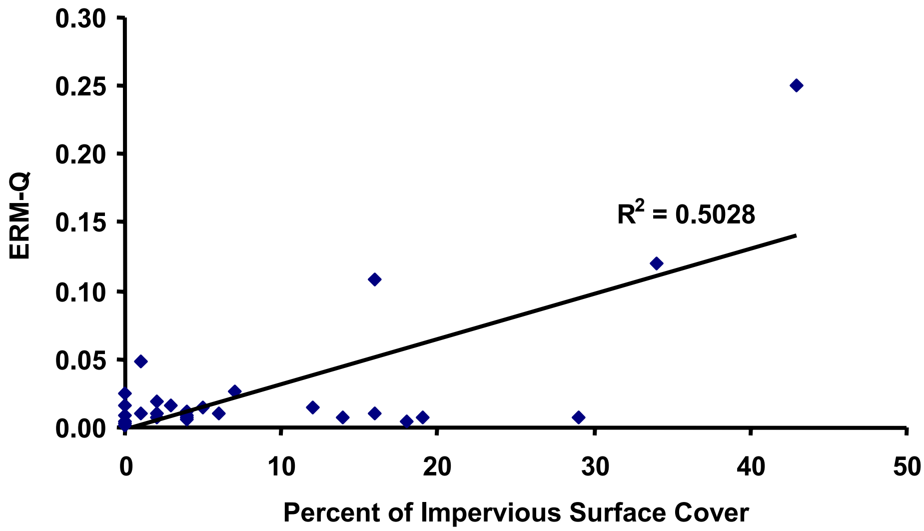


Figure 8. Linear regressions of ERM-Q versus various levels of urban cover for open water stations at HUC level.

Open Water Habitat



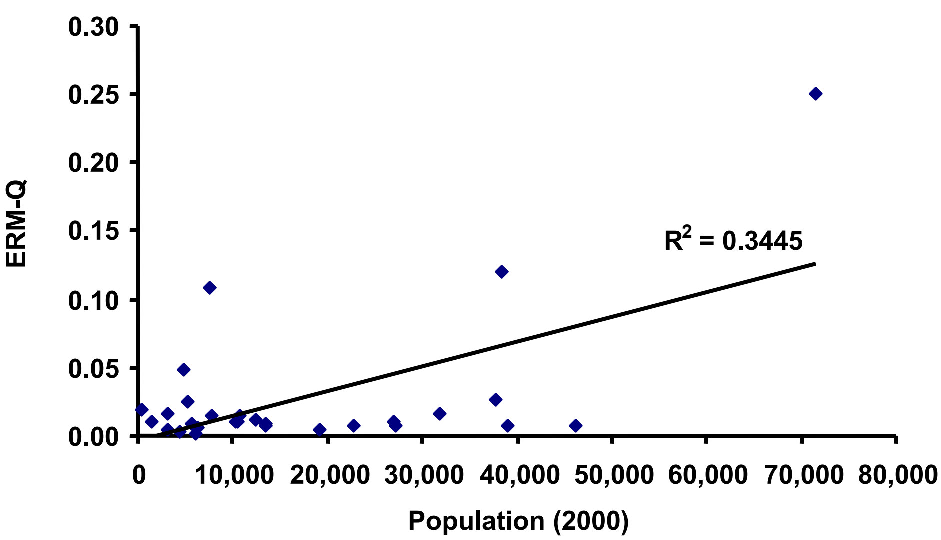


Figure 9. Linear regressions of ERM-Q versus impervious surface cover and year 2000 population for open water stations at HUC level.

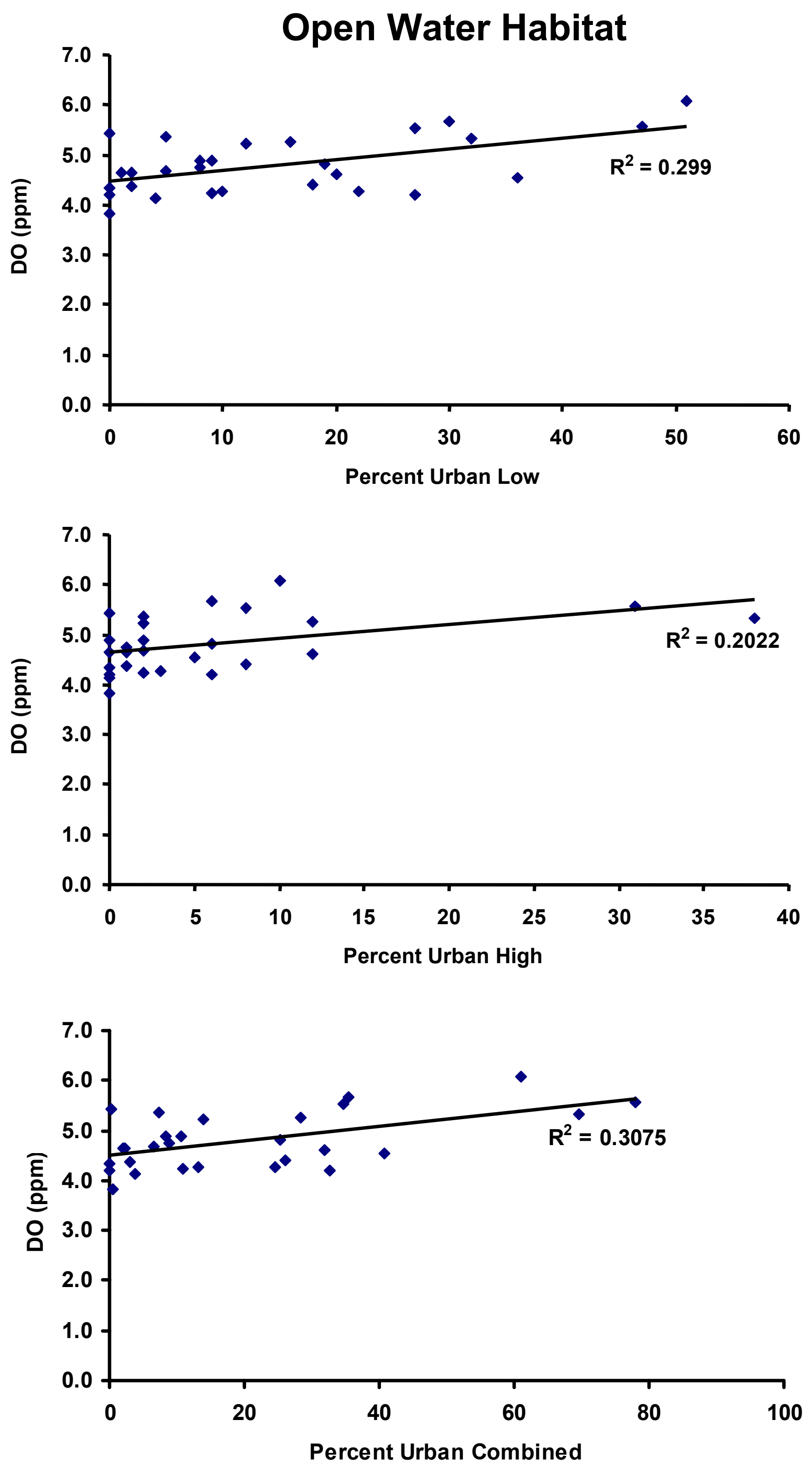


Figure 10. Linear regressions for Dissolved oxygen versus various levels of urban cover for open water stations at HUC level.

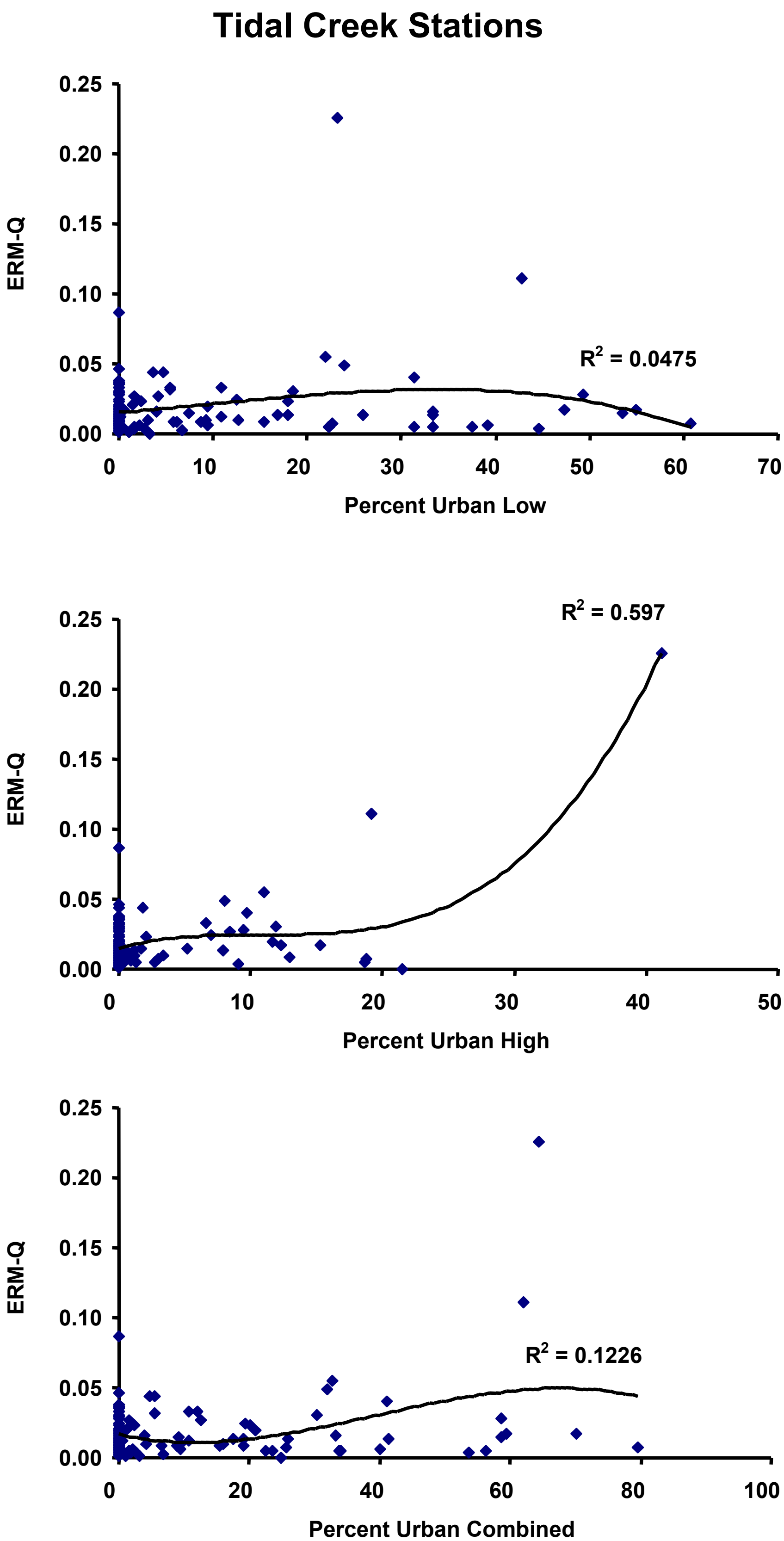


Figure 11. Third order polynomial regressions of ERM-Q versus various levels of urban cover for tidal creek stations at station level.

Open Water Stations

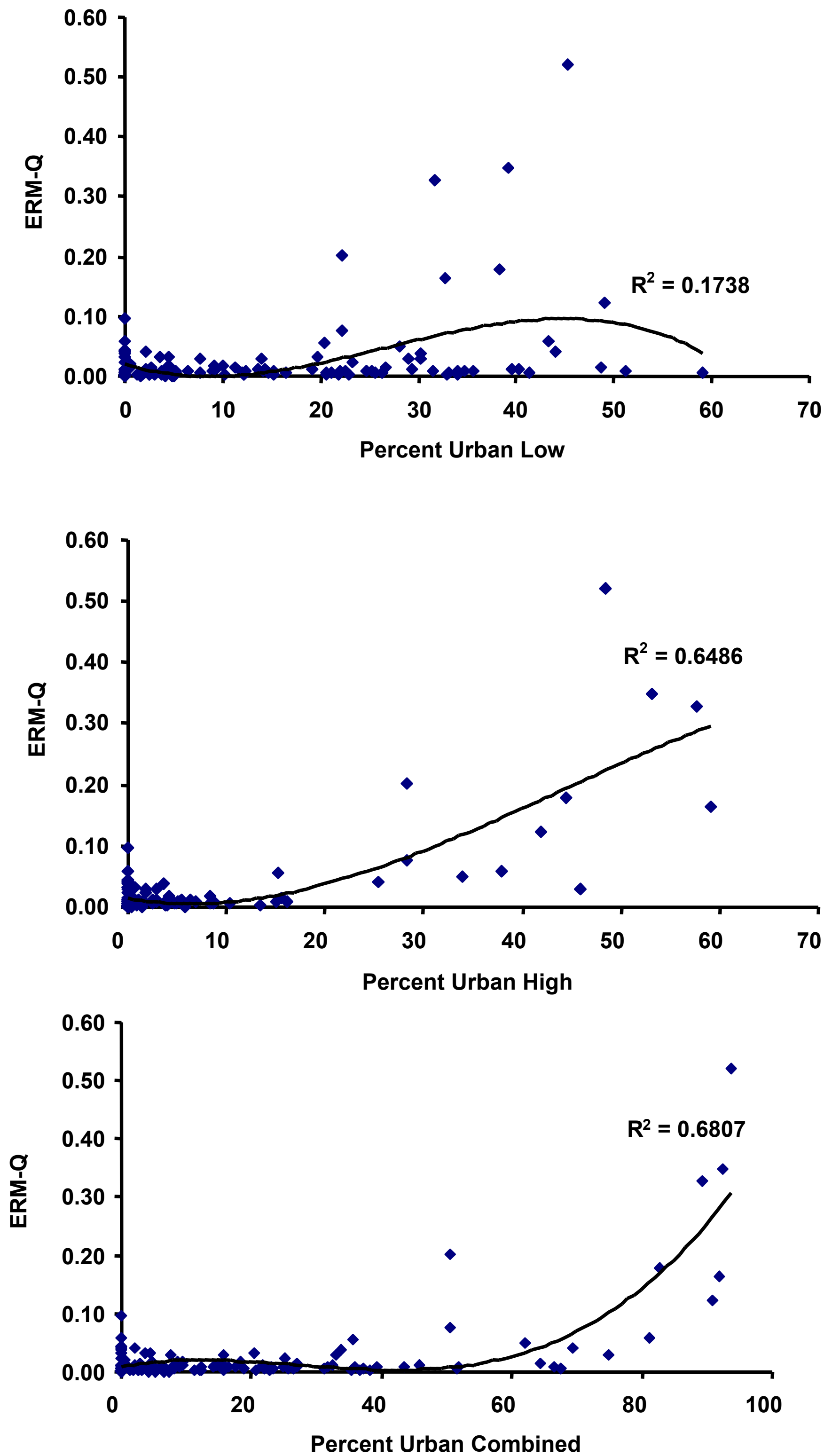


Figure 12. Third order polynomial regressions of ERM-Q versus various levels of urban cover for open water stations at station level.

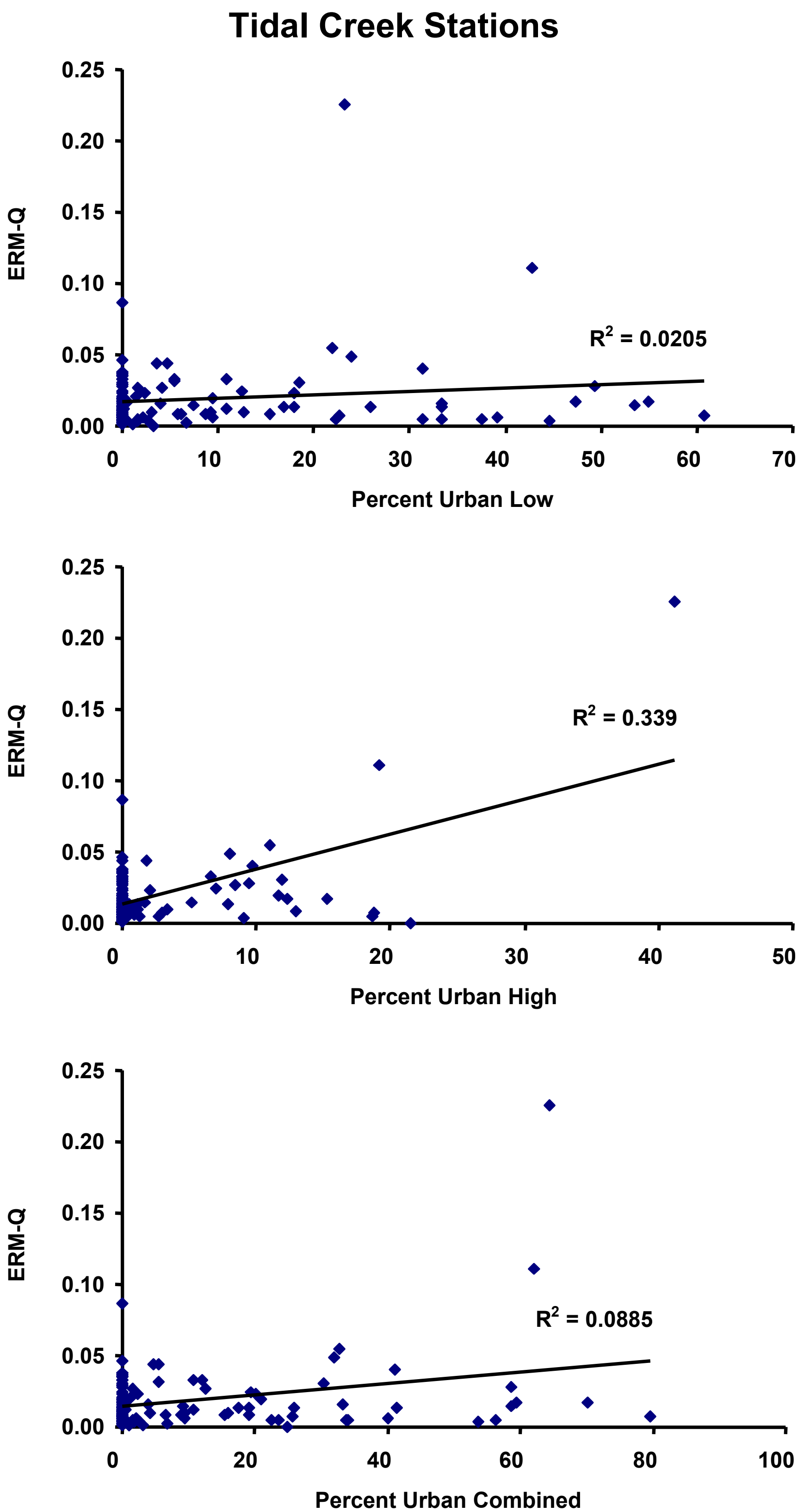


Figure 13. Linear regressions of ERM-Q versus various levels of urban cover for tidal creek stations at station level.

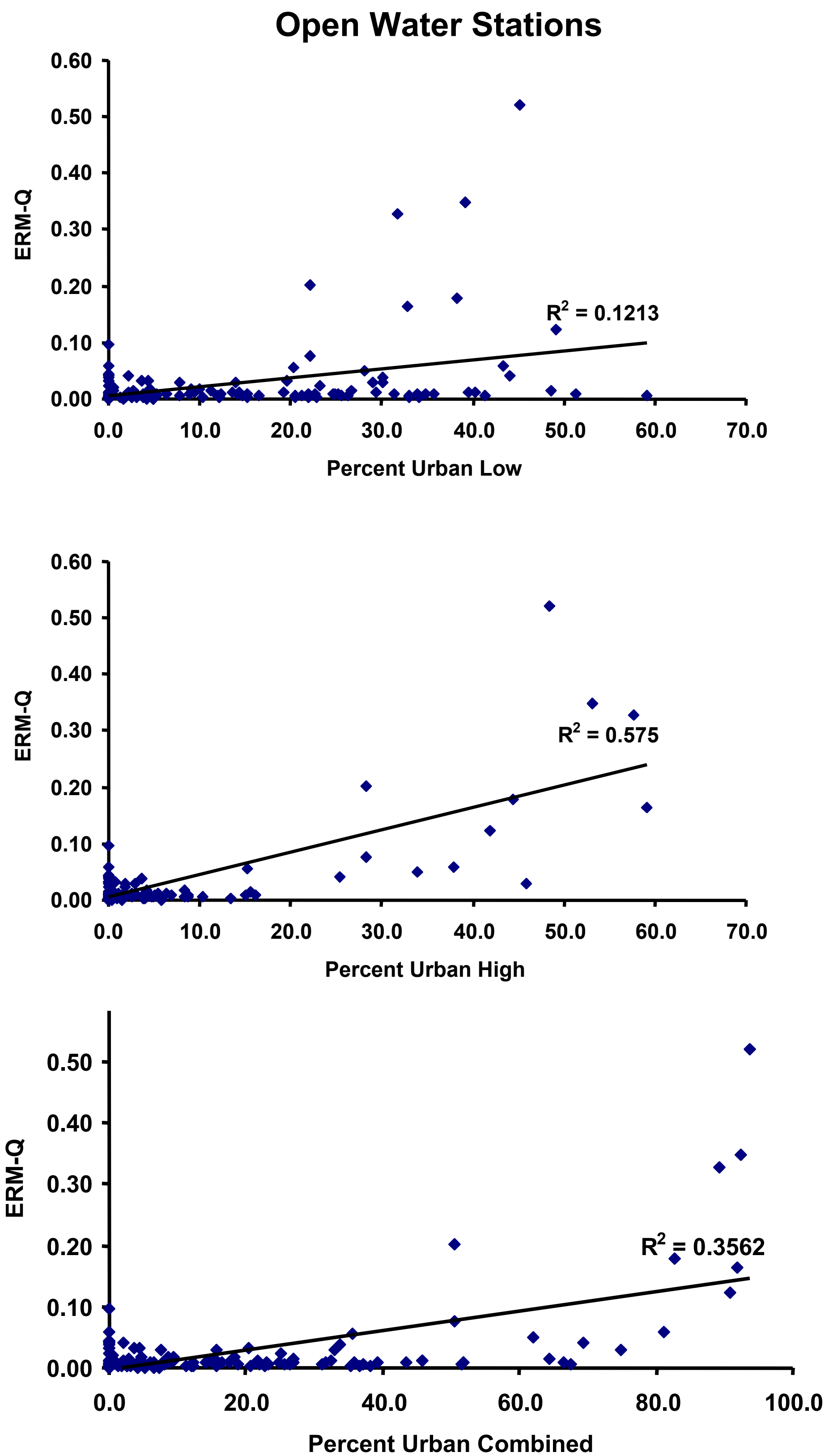


Figure 14. Linear regressions of ERM-Q versus various levels of urban cover for open water stations at station level.

Appendix 1. Summary of land use patterns for 30 14-digit Hydrologic Unit Codes (HUCs) in the coasal zone of South Carolina.
Values are in hectares.

HUC	Total Hectares	Total Upland Hectares	Scrub/Shrub Wetland + Forested Wetland	Bare Land	Grassland/Pasture + scrub/shrub	Deciduous Forest + Mixed Forest	Evergreen Forest	Cultivated Land	Urban (low)	Urban (high)	Urban (combined)	Impervious Surface	Population [2000]
03040207020130	4,116	3,762	87	45	699	330	1,224	69	1,020	288	1,308	451	7,737
03040207020160	3,006	2,381	52	475	275	72	450	5	673	379	1,052	667	8,425
03040207020200	4,198	2,851	74	213	151	215	1,264	3	583	348	931	513	19,189
03040207030060	4,592	3,776	198	6	386	308	1,751	59	600	468	1,068	604	7,654
03040207040020	10,271	4,776	301	322	307	301	3,419	24	71	31	102	0	6,196
03040207040030	5,066	2,033	150	0	94	152	1,633	3	1	0	1	0	4,330
03040207040040	11,153	5,817	403	68	466	488	3,922	80	279	111	390	58	4,761
03050112060030	13,983	6,374	489	38	314	411	5,041	58	17	6	23	0	5,744
03050201050020	8,910	5,788	380	2	483	282	543	62	1,836	2,200	4,036	1,968	38,447
03050201080020	12,845	8,401	242	18	649	542	4,591	165	1,548	646	2,194	1,176	22,833
03050202040020	8,291	5,597	194	0	67	333	629	4	2,646	1,724	4,370	2,407	71,569
03050202060010	15,633	2,749	275	140	198	285	1,609	40	147	55	202	0	31,897
03050202070020	3,010	2,063	137	0	15	107	533	1	1,058	212	1,270	598	38,965
03050202070030	8,016	2,095	125	199	214	161	647	4	620	125	745	147	37,725
03050202070040	7,899	3,995	132	280	332	329	2,128	464	316	14	330	240	13,501
03050205060070	11,333	5,776	232	146	526	576	3,753	326	137	80	217	116	1,553
03050205070030	14,800	6,659	385	83	730	832	3,600	871	145	13	158	0	5,373
03050205070040	12,891	8,692	467	83	988	1,062	4,843	910	310	29	339	522	12,426
03050208010070	15,224	9,371	1,166	16	805	1,567	5,766	51	0	0	0	0	3,108
03050208040010	14,608	11,653	1,949	0	1,535	1,545	6,359	215	40	10	50	233	435
03050208090060	4,854	2,766	128	1	440	481	1,244	168	245	59	304	83	3,259
03050208090070	13,381	5,662	322	45	1,086	999	2,261	114	697	138	835	226	27,296
03050208090100	15,255	10,851	871	421	1,636	2,086	3,989	433	1,106	309	1,415	543	10,818
03050208100010	15,443	7,467	271	18	345	480	3,610	296	2,026	421	2,447	448	10,399
03050208100020	12,732	3,697	87	22	130	147	2,248	152	812	99	911	148	6,257
03050208100050	10,874	4,836	230	187	475	428	1,993	294	934	295	1,229	919	46,139
03050208100060	22,674	6,237	560	376	513	516	2,901	700	575	96	671	62	10,567
03050208110030	10,435	6,739	504	55	827	1,276	3,220	257	536	64	600	135	13,478
03050208110040	7,194	5,292	206	195	446	318	1,972	2	1,905	248	2,153	847	27,000
03050208110050	9,031	3,610	398	75	455	551	2,018	12	101	0	101	0	8,509

Appendix 2. Summary of land use patterns for 30 14-digit Hyrdologic Unit Codes (HUCs) in trhe coastal zone of South Carolina. Values represent % of upland habitat.

HUC	Total Hectares	Total Upland Hectares	Scrub/Shrub Wetland + Forested Wetland	Bare Land	Grassland/Pasture + scrub/shrub	Deciduous Forest + Mixed Forest	Evergreen Forest	Cultivated Land	Urban (low)	Urban (high)	Urban (combined)	Impervious Surface
03040207020130	4,116	3,762	2.3	1.2	18.6	8.8	32.5	1.8	27.1	7.7	34.8	12.0
03040207020160	3,006	2,381	2.2	19.9	11.5	3.0	18.9	0.2	28.3	15.9	44.2	28.0
03040207020200	4,198	2,851	2.6	7.5	5.3	7.5	44.3	0.1	20.4	12.2	32.7	18.0
03040207030060	4,592	3,776	5.2	0.2	10.2	8.2	46.4	1.6	15.9	12.4	28.3	16.0
03040207040020	10,271	4,776	6.3	6.7	6.4	6.3	71.6	0.5	1.5	0.6	2.1	0.0
03040207040030	5,066	2,033	7.4	0.0	4.6	7.5	80.3	0.1	0.0	0.0	0.0	0.0
03040207040040	11,153	5,817	6.9	1.2	8.0	8.4	67.4	1.4	4.8	1.9	6.7	1.0
03050112060030	13,983	6,374	7.7	0.6	4.9	6.4	79.1	0.9	0.3	0.1	0.4	0.0
03050201050020	8,910	5,788	6.6	0.0	8.3	4.9	9.4	1.1	31.7	38.0	69.7	34.0
03050201080020	12,845	8,401	2.9	0.2	7.7	6.5	54.6	2.0	18.4	7.7	26.1	14.0
03050202040020	8,291	5,597	3.5	0.0	1.2	5.9	11.2	0.1	47.3	30.8	78.1	43.0
03050202060010	15,633	2,749	10.0	5.1	7.2	10.4	58.5	1.5	5.3	2.0	7.3	0.0
03050202070020	3,010	2,063	6.6	0.0	0.7	5.2	25.8	0.0	51.3	10.3	61.6	29.0
03050202070030	8,016	2,095	6.0	9.5	10.2	7.7	30.9	0.2	29.6	6.0	35.6	7.0
03050202070040	7,899	3,995	3.3	7.0	8.3	8.2	53.3	11.6	7.9	0.4	8.3	6.0
03050205060070	11,333	5,776	4.0	2.5	9.1	10.0	65.0	5.6	2.4	1.4	3.8	2.0
03050205070030	14,800	6,659	5.8	1.2	11.0	12.5	54.1	13.1	2.2	0.2	2.4	0.0
03050205070040	12,891	8,692	5.4	1.0	11.4	12.2	55.7	10.5	3.6	0.3	3.9	4.0
03050208010070	15,224	9,371	12.4	0.2	8.6	16.7	61.5	0.5	0.0	0.0	0.0	0.0
03050208040010	14,608	11,653	16.7	0.0	13.2	13.3	54.6	1.8	0.3	0.1	0.4	2.0
03050208090060	4,854	2,766	4.6	0.0	15.9	17.4	45.0	6.1	8.9	2.1	11.0	3.0
03050208090070	13,381	5,662	5.7	0.8	19.2	17.6	39.9	2.0	12.3	2.4	14.7	4.0
03050208090100	15,255	10,851	8.0	3.9	15.1	19.2	36.8	4.0	10.2	2.8	13.0	5.0
03050208100010	15,443	7,467	3.6	0.2	4.6	6.4	48.3	4.0	27.1	5.6	32.8	6.0
03050208100020	12,732	3,697	2.4	0.6	3.5	4.0	60.8	4.1	22.0	2.7	24.6	4.0
03050208100050	10,874	4,836	4.8	3.9	9.8	8.9	41.2	6.1	19.3	6.1	25.4	19.0
03050208100060	22,674	6,237	9.0	6.0	8.2	8.3	46.5	11.2	9.2	1.5	10.8	1.0
03050208110030	10,435	6,739	7.5	0.8	12.3	18.9	47.8	3.8	8.0	0.9	8.9	2.0
03050208110040	7,194	5,292	3.9	3.7	8.4	6.0	37.3	0.0	36.0	4.7	40.7	16.0
03050208110050	9,031	3,610	11.0	2.1	12.6	15.3	55.9	0.3	2.8	0.0	2.8	0.0

Appendix 3. Summary of land use patterns within a 1 km radius buffer of the tidal creek stations sampled by the SCDNR. All values are in hectares.

Station	Total Hectares	Total Upland Hectares	Scrub/Shrub Wetland + Forested Wetland	Bare Land	Grassland/Pasture + Scrub/Shrub	Deciduous Forest + Mixed Forest	Evergreen Forest	Cultivated Land	Urban (low)	Urban (high)	Urban (combined)
BBS1	323	209.5	7.1	7.4	31.2	6.8	70.5	0.0	70.0	16.5	86.5
CP95KIA	324	99.4	4.8	0.0	9.2	9.6	59.7	10.6	5.5	0.0	5.5
CP95LON	322	304.3	28.5	0.0	54.9	69.8	133.3	17.8	0.0	0.0	0.0
MR1-01	324	198.8	18.5	0.5	12.0	24.1	115.9	25.7	2.1	0.0	2.1
MR3-03	322	14.8	1.9	0.3	0.4	0.6	10.6	0.0	1.0	0.0	1.0
MR3-04	322	75.2	6.8	1.2	6.2	2.6	28.3	0.0	29.4	0.7	30.2
NT01598	322	277.7	22.1	0.0	5.8	17.5	66.8	0.2	131.2	34.1	165.3
NT01599	322	106.0	6.6	0.0	1.6	4.6	24.9	0.0	24.7	43.7	68.3
NT01651	322	6.7	3.2	0.3	0.0	0.4	2.2	0.0	0.7	0.0	0.7
NT022301	321	223.6	35.4	0.0	7.9	6.8	34.3	0.5	95.7	42.9	138.6
OBS1	322	205.7	12.3	2.6	33.2	26.5	111.1	8.7	7.6	3.8	11.3
OBS2	323	157.5	8.9	1.2	6.2	11.2	127.6	0.2	2.3	0.0	2.3
OBS3	322	130.6	6.8	1.2	17.6	18.4	80.4	1.1	5.2	0.0	5.2
RT00501	322	18.1	17.6	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RT00502	322	104.7	1.0	0.0	7.1	9.4	85.7	1.5	0.0	0.0	0.0
RT00503	323	64.5	0.4	0.0	0.2	2.0	49.7	0.0	11.6	0.7	12.3
RT00504	322	130.0	1.4	0.0	5.2	9.3	66.7	3.5	43.5	0.5	43.9
RT00505	322	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RT00517	325	44.3	19.1	0.2	0.3	3.1	21.5	0.0	0.2	0.0	0.2
RT00518	322	46.4	1.1	0.0	9.5	4.2	31.1	0.6	0.0	0.0	0.0
RT00519	322	82.5	8.6	0.0	0.8	10.2	61.5	1.1	0.2	0.3	0.5
RT00520	324	37.4	5.1	8.6	8.6	4.5	10.6	0.0	0.0	0.0	0.0
RT00521	322	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RT00523	321	154.5	0.2	3.0	1.8	4.9	112.2	0.0	14.5	18.0	32.5
RT00525	322	22.0	3.3	0.0	0.6	2.7	15.3	0.0	0.0	0.0	0.0
RT00526	323	139.5	0.2	0.0	3.9	9.2	78.3	3.2	33.5	11.3	44.7
RT00528	323	120.4	14.2	0.0	2.8	23.4	79.4	0.6	0.0	0.0	0.0
RT00530	323	0.5	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RT00531	323	151.6	0.4	0.0	5.6	6.0	132.8	4.1	2.6	0.0	2.6
RT00541	323	7.4	1.2	3.6	0.0	0.4	2.3	0.0	0.0	0.0	0.0
RT00542	323	173.7	8.3	0.4	17.5	20.9	67.9	58.9	0.0	0.0	0.0
RT00543	322	16.8	0.0	0.0	1.2	0.7	14.9	0.0	0.0	0.0	0.0
RT00544	323	39.3	5.4	4.5	1.6	0.9	26.9	0.0	0.0	0.0	0.0
RT00545	324	193.7	0.5	73.9	32.3	13.8	24.7	0.6	6.4	41.6	48.0
RT00546	325	130.8	8.9	0.9	29.2	16.0	72.3	1.4	2.2	0.0	2.2
RT00547	323	33.9	3.2	0.0	10.1	3.2	14.5	3.1	0.0	0.0	0.0
RT00548	323	10.9	0.3	1.5	0.5	0.2	6.4	1.9	0.2	0.0	0.2
RT00549	322	244.2	1.5	0.0	48.6	20.0	69.0	24.8	53.4	26.8	80.2
RT00550	322	129.0	0.2	7.4	3.2	7.1	42.0	0.0	57.4	11.7	69.1
RT00554	322	30.7	11.4	0.0	0.0	1.7	17.6	0.0	0.0	0.0	0.0
RT00556	322	143.9	9.1	1.2	6.4	9.5	114.5	0.2	3.2	0.0	3.2
RT00557	323	201.0	8.0	0.0	27.5	26.3	88.0	38.0	11.6	1.5	13.1
RT00558	323	63.4	8.6	1.6	10.1	7.7	15.9	19.4	0.0	0.0	0.0
RT01602	322	187.6	8.7	0.5	18.2	27.4	87.1	43.6	2.1	0.0	2.1
RT01603	324	34.5	0.8	0.0	3.4	4.0	25.8	0.5	0.0	0.0	0.0
RT01604	323	188.2	15.1	0.0	77.9	40.4	54.8	0.0	0.0	0.0	0.0
RT01606	322	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RT01619	323	2.3	1.3	0.0	0.0	0.2	0.5	0.0	0.4	0.0	0.4
RT01624	323	42.8	26.6	0.0	0.5	2.1	12.4	0.0	1.2	0.0	1.2

Appendix 3. Summary of land use patterns within a 1 km radius of the tidal creek stations sampled by the SCDNR. All values are in hectares.

Station	Total Hectares	Total Upland Hectares	Scrub/Shrub Wetland + Forested Wetland	Bare Land	Grassland/Pasture + Scrub/Shrub	Deciduous Forest + Mixed Forest	Evergreen Forest	Cultivated Land	Urban (low)	Urban (high)	Urban (combined)
RT01625	323	19.1	0.2	0.6	5.5	3.2	9.5	0.0	0.0	0.0	0.0
RT01628	324	145.2	0.2	0.0	6.4	9.6	68.0	1.4	45.5	14.0	59.5
RT01633	324	118.1	8.4	1.2	30.0	6.1	58.3	0.0	6.4	7.7	14.1
RT01642	322	123.8	13.1	22.1	18.1	10.7	52.6	7.2	0.0	0.0	0.0
RT01643	323	39.3	8.1	2.7	11.3	7.7	9.5	0.0	0.0	0.0	0.0
RT01644	323	151.8	1.4	0.2	10.0	9.3	41.8	0.0	74.8	14.4	89.2
RT01645	323	0.7	0.3	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0
RT01646	321	27.5	4.3	0.3	2.9	5.6	14.4	0.1	0.0	0.0	0.0
RT01647	322	128.0	9.2	0.0	14.4	13.7	77.9	12.9	0.0	0.0	0.0
RT01648	322	2.5	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RT01649	322	34.5	3.5	0.0	0.4	1.9	28.2	0.5	0.0	0.0	0.0
RT01650	324	119.1	1.6	11.2	31.8	11.1	63.5	0.0	0.0	0.0	0.0
RT01652	322	36.4	1.2	0.2	3.8	2.4	22.2	6.6	0.0	0.0	0.0
RT01653	323	120.8	2.8	0.0	1.9	4.4	90.0	0.6	20.4	0.6	21.1
RT01654	324	1.3	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RT01655	324	115.6	1.4	0.2	2.8	6.1	40.2	0.0	43.3	21.6	64.9
RT01664	323	45.5	5.9	3.2	5.6	1.9	22.7	1.9	4.2	0.0	4.2
RT01665	324	53.9	4.1	0.5	5.2	3.3	19.8	4.5	10.0	6.4	16.4
RT01668	322	1.1	0.4	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RT022002	322	8.2	4.5	0.2	0.0	0.2	2.6	0.0	0.7	0.0	0.7
RT022004	323	9.8	4.5	0.0	0.4	0.8	4.1	0.0	0.0	0.0	0.0
RT022005	322	7.1	4.2	0.3	0.0	2.0	0.6	0.0	0.0	0.0	0.0
RT022006	323	102.8	3.2	5.0	4.0	4.2	4.6	0.0	62.4	19.4	81.7
RT022007	323	46.5	1.7	0.0	1.3	3.2	40.1	0.2	0.0	0.0	0.0
RT022008	323	0.7	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0
RT022009	324	24.7	0.6	0.0	2.9	2.0	18.5	0.6	0.0	0.0	0.0
RT022013	323	91.1	0.0	0.0	0.2	2.1	85.9	0.2	2.8	0.0	2.8
RT022015	323	20.8	7.1	2.1	7.4	2.7	1.5	0.0	0.0	0.0	0.0
RT022016	324	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RT022017	322	200.4	12.2	0.0	19.3	43.8	124.8	0.3	0.0	0.0	0.0
RT022019	322	15.2	0.2	0.0	0.4	0.9	13.8	0.0	0.0	0.0	0.0
RT022021	324	170.3	8.2	0.2	16.7	10.8	131.7	2.8	0.0	0.0	0.0
RT022022	323	163.5	10.0	0.2	13.9	6.6	94.3	0.0	36.5	2.1	38.6
RT022027	322	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RT022028	322	87.8	0.2	0.0	2.2	3.5	71.0	0.0	3.6	7.4	11.0
RT022030	321	226.8	177.8	0.0	0.4	1.0	47.6	0.0	0.0	0.0	0.0
RT022152	324	30.4	23.2	0.4	1.3	3.0	1.2	0.0	1.4	0.0	1.4
RT022153	321	211.7	10.4	4.4	28.9	34.7	124.4	4.1	4.9	0.0	4.9
RT022154	323	44.7	1.3	0.0	0.4	4.9	30.8	0.3	5.7	1.5	7.2
RT022155	322	64.9	0.6	0.0	0.4	2.7	61.2	0.0	0.0	0.0	0.0
RT022156	323	7.7	3.7	0.5	0.0	0.2	2.6	0.0	0.7	0.0	0.7
RT022157	322	109.3	2.7	1.5	8.2	7.9	57.9	6.6	24.3	0.2	24.5
RT022160	323	78.5	9.1	1.0	2.7	2.3	36.7	0.0	24.6	2.2	26.7
RT022162	322	23.9	0.2	0.0	0.7	0.5	21.5	0.0	0.7	0.3	1.0
RT022164	322	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RT022165	322	46.2	2.3	0.0	6.5	4.7	29.6	3.1	0.0	0.0	0.0
RT022167	322	63.7	3.7	0.0	0.5	4.5	54.5	0.5	0.0	0.0	0.0
RT022170	323	6.6	1.4	0.0	0.2	0.9	4.1	0.0	0.0	0.0	0.0
RT022171	322	28.8	1.1	0.3	2.4	3.9	11.8	9.4	0.0	0.0	0.0

Appendix 3. Summary of land use patterns within a 1 km radius of the tidal creek stations sampled by the SCDNR.
All values are in hectares.

Station	Total Hectares	Total Upland Hectares	Scrub/Shrub Wetland + Forested Wetland	Bare Land	Grassland/Pasture + Scrub/Shrub	Deciduous Forest + Mixed Forest	Evergreen Forest	Cultivated Land	Urban (low)	Urban (high)	Urban (combined)
RT022282	322	183.5	23.9	0.0	27.8	15.5	81.2	0.0	11.4	23.7	35.1
RT99001	324	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RT99002	322	1.4	0.1	0.0	0.8	0.3	0.0	0.2	0.0	0.0	0.0
RT99003	323	55.8	4.5	0.0	1.0	1.2	48.9	0.0	0.3	0.0	0.3
RT99004	323	60.5	3.2	0.0	4.7	5.0	28.1	19.5	0.0	0.0	0.0
RT99005	323	157.7	0.1	0.0	0.2	6.6	119.2	0.0	28.4	3.3	31.7
RT99006	322	171.1	7.8	23.9	17.6	6.7	115.0	0.0	0.0	0.0	0.0
RT99007	323	92.8	1.0	0.2	2.5	5.6	18.3	0.2	50.9	14.1	65.1
RT99008	322	1.3	0.2	0.0	0.0	0.2	0.9	0.0	0.0	0.0	0.0
RT99009	322	195.5	3.5	0.4	34.8	20.3	129.5	7.0	0.0	0.0	0.0
RT99010	323	135.0	8.6	0.0	18.4	32.9	73.9	1.4	0.0	0.0	0.0
RT99012	322	37.0	18.3	0.0	2.0	2.1	14.7	0.0	0.0	0.0	0.0
RT99013	323	3.3	2.7	0.0	0.3	0.0	0.0	0.0	0.4	0.0	0.4
RT99017	322	248.2	9.2	0.0	0.5	13.0	80.0	0.2	132.6	12.9	145.4
RT99019	322	146.4	10.2	0.2	22.1	11.7	77.7	24.7	0.0	0.0	0.0
RT99021	323	18.0	0.9	0.0	3.1	3.7	6.8	0.0	2.3	1.3	3.5
RT99022	322	121.5	23.9	0.8	4.5	7.7	53.1	0.0	31.5	0.0	31.5
RT99024	322	68.6	3.5	0.2	7.2	6.7	50.1	0.9	0.0	0.0	0.0
RT99026	324	49.1	5.4	0.0	4.8	3.0	36.0	0.0	0.0	0.0	0.0
RT99027	324	162.1	0.2	0.0	28.3	9.6	110.5	13.5	0.0	0.0	0.0
RT99028	322	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RT99029	322	57.6	2.0	0.3	4.6	6.5	14.1	30.2	0.0	0.0	0.0
RT99030	322	118.4	1.6	0.0	3.5	2.6	99.6	0.2	8.9	2.0	10.9
RT99036	321	3.4	0.6	0.2	0.3	0.0	2.3	0.0	0.0	0.0	0.0
RT99037	322	221.4	183.7	0.0	0.7	0.6	36.4	0.0	0.0	0.0	0.0
RT99038	322	1.1	0.7	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.4
RT99039	322	48.0	3.2	0.0	10.8	2.8	27.9	3.3	0.0	0.0	0.0
RT99040	322	95.9	1.2	0.0	4.1	2.7	62.6	0.7	21.7	2.9	24.6

Appendix 4. Summary of land use patterns within a 2 km radius buffer of the open water stations sampled by the SCDNR. All values are in hectares.

Station	Total Hectares	Total Upland Hectares	Scrub/Shrub Wetland + Forested Wetland	Bare Land	Grassland/Pasture + Scrub/Shrub	Deciduous Forest + Mixed Forest	Evergreen Forest	Cultivated Land	Urban (low)	Urban (high)	Urban (combined)
BBS2	1271	805.0	32.0	4	72	29	299	0	318	51	369
BBS3	1270	869.0	36.0	1	81	46	364	0	295	46	341
BBS4	1271	566.0	21.0	9	23	26	270	1	193	23	216
BBS5	1272	470.0	17.4	10	20.61	22.23	243	1	142	14	155
BBS6	1271	537.0	55.2	3	31.5	40.59	265	0	137	5	142
CP94082	1273	817.8	74.5	4	86.04	69.21	158	13	182	231	412
CP94KOP	1272	631.3	5.3	0	7.2	12.42	15	0	285	306	591
CP94SPY	1271	750.8	42.2	0	4.68	16.02	16	1	238	433	671
CP95150	1272	270.2	52.8	0	14.85	15.66	186	1	0	0	0
CP95151	1271	763.4	38.0	0	2.97	33.12	69	0	331	289	620
CP95152	1272	795.5	57.3	0	2.7	25.83	52	0	304	353	657
CP95154	1272	222.3	54.9	43	49.86	42.03	33	0	0	0	0
CP95156	1271	191.3	37.7	0	9.63	12.6	122	9	0	0	0
CP97082	1273	817.8	74.5	4	86.04	69.21	158	13	182	231	412
CP97156	1271	191.3	37.7	0	9.63	12.6	122	9	0	0	0
MR1-02	1272	860.3	49.5	4	108.09	179.73	399	83	36	1	36
MR1-03	1270	868.4	48.3	2	102.06	160.56	441	81	33	1	34
MR2-01	1272	691.5	27.5	4	17.01	96.12	289	4	228	26	254
MR2-02	1271	385.7	14.4	2	28.53	54.81	236	3	47	0	47
MR2-03	1271	678.8	47.5	17	59.4	53.1	477	5	21	0	21
MR3-01	1271	208.4	18.4	5	70.65	17.37	84	2	11	0	11
NO01098	1273	671.9	14.8	0	8.46	14.13	14	0	264	357	620
NO01099	1275	852.8	74.1	4	65.7	64.71	106	8	240	289	529
NO026302	1272	871.2	16.8	0	44.1	75.51	566	4	144	21	165
OBS4	1274	656.6	40.6	10	139.68	152.73	125	170	18	0	18
OBS5	1273	942.9	56.7	20	199.17	286.56	224	137	20	0	20
RO00006	1273	193.8	10.2	96	18	17.91	52	0	0	0	0
RO00007	1273	644.9	325.3	0	74.97	85.59	101	10	10	38	48
RO00008	1271	114.3	2.3	12	7.47	2.43	90	0	0	0	0
RO00009	1271	431.5	10.1	1	10.26	20.61	112	0	210	67	277
RO00010	1273	282.3	21.2	7	32.4	31.05	185	0	5	0	5
RO00015	1273	250.7	19.3	0	10.35	21.6	177	1	11	10	21
RO00016	1272	474.0	24.1	1	29.88	35.28	354	1	25	5	29
RO00017	1273	11.0	3.6	2	3.87	0.72	1	0	0	0	0
RO00018	1273	10.0	6.7	1	1.62	0.09	0	0	0	0	0
RO00019	1271	537.9	22.1	2	39.87	110.07	335	5	24	0	24
RO00021	1275	285.3	25.7	1	30.96	29.16	190	9	0	0	0
RO00023	1272	121.8	4.8	1	0.54	4.14	78	0	32	0	33
RO00024	1272	545.2	44.7	74	118.89	108.99	168	7	23	0	23
RO00033	1274	528.7	48.9	2	15.39	27.18	79	6	271	80	351
RO00034	1272	155.4	116.9	0	13.23	7.74	14	2	1	0	1
RO00035	1270	182.4	7.5	0	20.52	2.88	104	47	0	0	0
RO00036	1273	411.9	18.3	0	72.36	68.49	213	20	18	1	20
RO00037	1272	0.5	0.2	0	0	0	0	0	0	0	0
RO00045	1271	602.8	47.8	2	81.45	73.08	299	6	91	3	94
RO00046	1273	467.8	60.7	0	75.96	89.37	231	11	0	0	0
RO00047	1274	78.3	18.1	18	12.24	3.24	17	0	10	0	10
RO00048	1274	422.1	20.3	82	94.5	30.06	89	36	60	10	70
RO00049	1271	45.3	6.6	14	3.06	0.18	11	1	10	0	10

Appendix 4. Summary of land use patterns within a 2 km radius buffer of the open water stations sampled by the SCDNR. All values are in hectares.

Station	Total Hectares	Total Upland Hectares	Scrub/Shrub Wetland + Forested Wetland	Bare Land	Grassland/Pasture + Scrub/Shrub	Deciduous Forest + Mixed Forest	Evergreen Forest	Cultivated Land	Urban (low)	Urban (high)	Urban (combined)
RO00055	1273	79.7	10.9	54	11.25	0.9	3	0	0	0	0
RO00056	1272	840.9	27.2	0	4.77	16.47	18	1	276	497	773
RO00057	1271	721.1	19.7	4	116.55	66.33	391	65	56	3	58
RO00058	1271	234.2	10.7	0	50.22	42.48	110	21	0	0	0
RO00059	1270	769.9	25.1	9	43.38	37.44	367	1	255	32	287
RO01109	1273	754.4	267.4	1	101.61	77.4	179	60	36	32	68
RO01111	1270	89.6	3.1	1	4.95	9.36	52	0	17	2	20
RO01112	1270	284.9	18.7	6	6.57	12.87	92	1	118	29	147
RO01114	1272	1043.3	134.3	0	153.72	96.21	574	30	50	4	55
RO01115	1274	73.9	0.8	6	17.1	6.12	42	2	0	0	0
RO01116	1272	114.7	31.6	11	37.08	12.24	23	0	0	0	0
RO01117	1272	330.9	25.8	8	26.55	31.05	212	1	21	5	26
RO01121	1273	477.4	34.7	0	37.53	40.41	183	20	144	17	161
RO01122	1272	54.5	8.6	1	17.46	16.83	9	2	0	0	0
RO01124	1270	360.5	17.7	0	2.61	12.6	230	1	91	6	97
RO01125	1273	377.6	20.5	4	46.17	66.33	163	0	74	3	77
RO01129	1272	84.0	18.0	8	5.49	5.04	35	0	9	4	13
RO01130	1273	1069.6	26.5	6	157.68	198.72	511	1	149	20	169
RO01131	1271	317.7	5.9	0	14.94	22.41	267	7	0	0	0
RO01132	1271	561.9	25.5	0	95.67	82.53	320	35	3	0	3
RO01133	1273	4.4	2.3	2	0	0	0	0	1	0	1
RO01144	1273	406.1	8.6	3	67.14	22.68	136	143	20	6	26
RO01145	1273	389.3	12.1	2	26.82	25.83	251	12	56	3	59
RO01146	1272	234.0	39.1	38	43.47	16.92	75	0	22	0	22
RO01147	1272	479.8	14.4	8	40.68	32.4	251	7	109	18	127
RO01148	1274	37.9	4.4	3	10.89	5.22	8	0	4	3	7
RO01161	1273	386.1	41.5	1	49.41	45.54	216	25	8	0	8
RO01162	1272	210.4	6.4	0	22.32	9.09	165	0	4	3	7
RO01164	1273	293.9	11.1	0	9	14.58	124	1	118	16	134
RO01165	1271	114.8	21.3	5	1.98	8.1	50	0	28	0	28
RO026001	1273	18.7	7.5	7	2.88	0.36	1	0	0	0	0
RO026002	1273	75.0	6.0	1	13	2	49	1	3	0	3
RO026003	1272	568.6	2.9	0	4.86	32.67	342	6	141	40	180
RO026006	1272	320.5	58.5	10	19.35	9.99	182	0	39	1	40
RO026007	1271	403.6	10.5	0	0.18	8.73	335	0	49	0	49
RO026008	1271	0.4	0.4	0	0	0	0	0	0	0	0
RO026009	1272	480.4	30.7	38	96.93	49.59	194	0	66	5	71
RO026010	1272	530.8	28.3	2	30.51	53.01	416	2	0	0	0
RO026011	1271	176.7	85.0	33	20.25	9.27	20	0	9	0	9
RO026012	1275	324.4	35.6	1	49.41	46.17	66	12	71	43	115
RO026013	1271	191.2	4.6	1	6.21	8.64	61	109	0	0	0
RO026014	1271	731.4	2.1	0	35.64	43.38	547	1	65	38	103
RO026016	1272	210.8	19.1	8	6.21	13.14	111	0	49	4	53
RO026017	1273	416.3	13.5	1	2.97	36.72	232	0	110	20	130
RO026019	1272	227.6	16.4	0	23.94	50.58	135	2	0	0	0
RO026020	1273	246.4	11.5	5	4.14	11.7	107	0	86	21	107
RO026021	1273	242.8	52.7	10	35.73	29.52	95	1	19	0	19
RO026022	1273	102.4	14.0	4	3.51	2.97	75	0	3	0	3
RO026023	1271	436.8	24.8	46	102.96	95.94	151	4	11	0	11

Appendix 4. Summary of land use patterns within a 2 km radius buffer of the open water stations sampled by the SCDNR. All values are in hectares.

Station	Total Hectares	Total Upland Hectares	Scrub/Shrub Wetland + Forested Wetland	Bare Land	Grassland/Pasture + Scrub/Shrub	Deciduous Forest + Mixed Forest	Evergreen Forest	Cultivated Land	Urban (low)	Urban (high)	Urban (combined)
RO026024	1272	957.7	22.1	16	216	162.99	432	1	99	9	107
RO026025	1272	32.5	2.9	3	7.92	1.62	17	0	0	0	0
RO026026	1272	180.2	13.0	9	5.67	7.83	20	3	107	15	122
RO026027	1274	10.7	3.6	2	3.69	0.72	1	0	0	0	0
RO026028	1272	744.7	18.4	0	124.56	34.47	9	0	216	342	558
RO026029	1273	144.6	66.2	0	32.13	20.43	24	2	0	0	0
RO026030	1272	577.8	2.8	0	4.32	10.35	35	0	284	242	525
RO026151	1271	121.7	12.0	0	9.81	20.07	80	0	0	0	0
RO026290	1272	651.4	66.0	0	112.05	72	103	67	132	99	231
RO99301	1271	490.6	6.4	0	102.6	34.2	336	11	0	0	0
RO99302	1272	486.7	95.0	0	87.21	65.16	225	15	0	0	0
RO99303	1272	248.5	17.8	18	17.28	15.39	121	1	36	22	58
RO99304	1271	928.0	59.2	16	202.5	291.87	189	152	17	0	17
RO99305	1270	56.0	10.4	13	3.24	0.18	16	1	12	0	12
RO99306	1273	215.4	1.7	118	7.02	8.01	25	0	46	10	56
RO99307	1273	817.1	249.5	0	132.66	144.99	287	3	0	0	0
RO99309	1273	442.2	15.2	0	1.98	14.49	307	1	97	5	102
RO99310	1273	112.3	12.3	20	11.52	3.24	41	0	23	2	25
RO99311	1275	145.4	24.1	5	32.4	12.6	72	0	0	0	0
RO99312	1273	434.4	20.2	0	49.77	42.48	238	43	40	1	41
RO99313	1271	645.7	36.5	0	96.12	108.99	234	56	98	15	113
RO99315	1270	969.1	38.5	5	63.09	175.95	600	74	12	0	12
RO99317	1272	150.8	16.7	47	9.81	11.88	66	0	0	0	0
RO99318	1272	145.9	2.3	10	5.58	1.44	126	0	0	0	0
RO99319	1273	119.0	5.3	1	12.33	3.6	57	1	35	4	39
RO99320	1273	185.0	11.0	1	42	7	119	1	4	0	4
RO99322	1272	533.9	85.3	0	9	19.98	48	1	235	136	371
RO99323	1274	136.4	1.4	0	9.09	8.37	95	23	0	0	0
RO99324	1273	312.5	56.3	4	61.02	74.43	105	1	11	0	11
RO99325	1272	297.5	15.0	18	88.56	48.6	114	4	9	0	9
RO99327	1271	706.1	27.4	2	208.89	71.55	328	21	27	20	47
RO99328	1272	44.3	0.6	1	1.71	1.17	40	0	0	0	0
RO99329	1272	429.8	4.1	0	10.17	19.62	161	12	153	70	223
RO99330	1271	859.0	37.0	1	113	38	361	0	270	39	309

Appendix 5. Summary of land use patterns within a 1 km radius buffer of the tidal creek stations sampled by the SCDNR. All values represent percent of total upland present within the buffer.

Station	Total Hectares	Total Upland Hectares	Scrub/Shrub Wetland + Forested Wetland	Bare Land	Grassland/Pasture + Scrub/Shrub	Deciduous Forest + Mixed Forest	Evergreen Forest	Cultivated Land	Urban (low)	Urban (high)	Urban (combined)
BBS1	323	209.5	3.4	3.5	14.9	3.3	33.6	0.0	33.4	7.9	41.3
CP95KIA	324	99.4	4.8	0.0	9.2	9.7	60.1	10.7	5.5	0.0	5.5
CP95LON	322	304.3	9.4	0.0	18.0	22.9	43.8	5.9	0.0	0.0	0.0
MR1-01	324	198.8	9.3	0.2	6.0	12.1	58.3	12.9	1.0	0.0	1.0
MR3-03	322	14.8	12.8	1.8	2.4	4.3	72.0	0.0	6.7	0.0	6.7
MR3-04	322	75.2	9.0	1.6	8.3	3.5	37.6	0.0	39.2	1.0	40.1
NT01598	322	277.7	8.0	0.0	2.1	6.3	24.1	0.1	47.3	12.3	59.5
NT01599	322	106.0	6.2	0.0	1.5	4.3	23.5	0.0	23.3	41.2	64.4
NT01651	322	6.7	47.3	4.1	0.0	5.4	32.4	0.0	10.8	0.0	10.8
NT022301	321	223.6	15.8	0.0	3.5	3.1	15.3	0.2	42.8	19.2	62.0
OBS1	322	205.7	6.0	1.3	16.1	12.9	54.0	4.2	3.7	1.8	5.5
OBS2	323	157.5	5.7	0.7	3.9	7.1	81.0	0.1	1.4	0.0	1.4
OBS3	322	130.6	5.2	0.9	13.4	14.1	61.5	0.8	4.0	0.0	4.0
RT00501	322	18.1	97.5	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RT00502	322	104.7	0.9	0.0	6.8	8.9	81.9	1.5	0.0	0.0	0.0
RT00503	323	64.5	0.6	0.0	0.3	3.1	77.0	0.0	18.0	1.1	19.1
RT00504	322	130.0	1.0	0.0	4.0	7.1	51.3	2.7	33.4	0.3	33.8
RT00505	322	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RT00517	325	44.3	43.1	0.4	0.6	6.9	48.6	0.0	0.4	0.0	0.4
RT00518	322	46.4	2.3	0.0	20.3	9.1	66.9	1.4	0.0	0.0	0.0
RT00519	322	82.5	10.4	0.0	1.0	12.3	74.5	1.3	0.2	0.3	0.5
RT00520	324	37.4	13.7	23.1	22.8	12.0	28.4	0.0	0.0	0.0	0.0
RT00521	322	0.2	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RT00523	321	154.5	0.1	1.9	1.2	3.1	72.6	0.0	9.4	11.6	21.0
RT00525	322	22.0	15.2	0.0	2.9	12.3	69.7	0.0	0.0	0.0	0.0
RT00526	323	139.5	0.1	0.0	2.8	6.6	56.1	2.3	24.0	8.1	32.1
RT00528	323	120.4	11.8	0.0	2.3	19.4	65.9	0.5	0.0	0.0	0.0
RT00530	323	0.5	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RT00531	323	151.6	0.2	0.0	3.7	4.0	87.6	2.7	1.7	0.0	1.7
RT00541	323	7.4	15.9	48.8	0.0	4.9	30.5	0.0	0.0	0.0	0.0
RT00542	323	173.7	4.8	0.2	10.1	12.0	39.1	33.9	0.0	0.0	0.0
RT00543	322	16.8	0.0	0.0	7.0	4.3	88.8	0.0	0.0	0.0	0.0
RT00544	323	39.3	13.7	11.4	4.1	2.3	68.4	0.0	0.0	0.0	0.0
RT00545	324	193.7	0.2	38.2	16.7	7.1	12.7	0.3	3.3	21.5	24.8
RT00546	325	130.8	6.8	0.7	22.3	12.3	55.3	1.0	1.7	0.0	1.7
RT00547	323	33.9	9.3	0.0	29.7	9.3	42.7	9.0	0.0	0.0	0.0
RT00548	323	10.9	2.5	14.0	4.1	1.7	58.7	17.4	1.7	0.0	1.7
RT00549	322	244.2	0.6	0.0	19.9	8.2	28.3	10.2	21.9	11.0	32.8
RT00550	322	129.0	0.1	5.7	2.4	5.5	32.6	0.0	44.5	9.1	53.6
RT00554	322	30.7	37.2	0.0	0.0	5.6	57.2	0.0	0.0	0.0	0.0
RT00556	322	143.9	6.3	0.8	4.4	6.6	79.5	0.1	2.2	0.0	2.2
RT00557	323	201.0	4.0	0.0	13.7	13.1	43.8	18.9	5.8	0.8	6.5
RT00558	323	63.4	13.5	2.6	15.9	12.2	25.1	30.7	0.0	0.0	0.0
RT01602	322	187.6	4.7	0.3	9.7	14.6	46.4	23.2	1.1	0.0	1.1
RT01603	324	34.5	2.3	0.0	9.9	11.5	74.9	1.3	0.0	0.0	0.0
RT01604	323	188.2	8.0	0.0	41.4	21.5	29.1	0.0	0.0	0.0	0.0
RT01606	322	0.4	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RT01619	323	2.3	53.8	0.0	0.0	7.7	23.1	0.0	15.4	0.0	15.4
RT01624	323	42.8	62.3	0.0	1.1	4.8	29.1	0.0	2.7	0.0	2.7

Appendix 5. Summary of land use patterns within a 1 km radius buffer of the tidal creek stations sampled by the SCDNR. All values represent percent of total upland present within the buffer.

Station	Total Hectares	Total Upland Hectares	Scrub/Shrub Wetland + Forested Wetland	Bare Land	Grassland/Pasture + Scrub/Shrub	Deciduous Forest + Mixed Forest	Evergreen Forest	Cultivated Land	Urban (low)	Urban (high)	Urban (combined)
RT01625	323	19.1	0.9	3.3	28.8	17.0	50.0	0.0	0.0	0.0	0.0
RT01628	324	145.2	0.1	0.0	4.4	6.6	46.9	1.0	31.3	9.7	41.0
RT01633	324	118.1	7.1	1.0	25.4	5.2	49.4	0.0	5.4	6.6	12.0
RT01642	322	123.8	10.5	17.9	14.6	8.7	42.5	5.8	0.0	0.0	0.0
RT01643	323	39.3	20.6	6.9	28.8	19.5	24.3	0.0	0.0	0.0	0.0
RT01644	323	151.8	0.9	0.1	6.6	6.1	27.5	0.0	49.3	9.5	58.7
RT01645	323	0.7	37.5	0.0	0.0	0.0	62.5	0.0	0.0	0.0	0.0
RT01646	321	27.5	15.7	1.0	10.5	20.3	52.3	0.3	0.0	0.0	0.0
RT01647	322	128.0	7.2	0.0	11.3	10.7	60.8	10.1	0.0	0.0	0.0
RT01648	322	2.5	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RT01649	322	34.5	10.2	0.0	1.0	5.5	81.7	1.6	0.0	0.0	0.0
RT01650	324	119.1	1.4	9.4	26.7	9.3	53.3	0.0	0.0	0.0	0.0
RT01652	322	36.4	3.2	0.5	10.4	6.7	61.1	18.1	0.0	0.0	0.0
RT01653	323	120.8	2.3	0.0	1.6	3.7	74.5	0.5	16.9	0.5	17.4
RT01654	324	1.3	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RT01655	324	115.6	1.2	0.2	2.4	5.3	34.8	0.0	37.5	18.7	56.2
RT01664	323	45.5	13.1	7.1	12.3	4.2	49.9	4.2	9.3	0.0	9.3
RT01665	324	53.9	7.7	1.0	9.7	6.2	36.7	8.3	18.5	11.9	30.4
RT01668	322	1.1	33.3	66.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RT022002	322	8.2	54.9	2.2	0.0	2.2	31.9	0.0	8.8	0.0	8.8
RT022004	323	9.8	45.9	0.0	3.7	8.3	42.2	0.0	0.0	0.0	0.0
RT022005	322	7.1	59.5	3.8	0.0	27.8	8.9	0.0	0.0	0.0	0.0
RT022006	323	102.8	3.2	4.9	3.9	4.1	4.5	0.0	60.7	18.8	79.5
RT022007	323	46.5	3.7	0.0	2.7	7.0	86.3	0.4	0.0	0.0	0.0
RT022008	323	0.7	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0
RT022009	324	24.7	2.6	0.0	11.7	8.0	75.2	2.6	0.0	0.0	0.0
RT022013	323	91.1	0.0	0.0	0.2	2.3	94.3	0.2	3.1	0.0	3.1
RT022015	323	20.8	34.2	10.0	35.5	13.0	7.4	0.0	0.0	0.0	0.0
RT022016	324	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RT022017	322	200.4	6.1	0.0	9.6	21.9	62.3	0.1	0.0	0.0	0.0
RT022019	322	15.2	1.2	0.0	2.4	5.9	90.5	0.0	0.0	0.0	0.0
RT022021	324	170.3	4.8	0.1	9.8	6.3	77.3	1.6	0.0	0.0	0.0
RT022022	323	163.5	6.1	0.1	8.5	4.0	57.7	0.0	22.3	1.3	23.6
RT022027	322	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RT022028	322	87.8	0.2	0.0	2.5	4.0	80.8	0.0	4.1	8.4	12.5
RT022030	321	226.8	78.4	0.0	0.2	0.4	21.0	0.0	0.0	0.0	0.0
RT022152	324	30.4	76.3	1.2	4.1	9.8	3.8	0.0	4.7	0.0	4.7
RT022153	321	211.7	4.9	2.1	13.6	16.4	58.8	1.9	2.3	0.0	2.3
RT022154	323	44.7	2.8	0.0	0.8	10.9	68.8	0.6	12.7	3.4	16.1
RT022155	322	64.9	1.0	0.0	0.6	4.2	94.3	0.0	0.0	0.0	0.0
RT022156	323	7.7	48.2	5.9	0.0	2.4	34.1	0.0	9.4	0.0	9.4
RT022157	322	109.3	2.5	1.4	7.5	7.2	53.0	6.0	22.2	0.2	22.4
RT022160	323	78.5	11.6	1.3	3.4	2.9	46.8	0.0	31.3	2.8	34.1
RT022162	322	23.9	0.8	0.0	3.0	1.9	90.2	0.0	3.0	1.1	4.2
RT022164	322	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RT022165	322	46.2	5.1	0.0	14.0	10.1	64.1	6.6	0.0	0.0	0.0
RT022167	322	63.7	5.8	0.0	0.8	7.1	85.6	0.7	0.0	0.0	0.0
RT022170	323	6.6	21.9	0.0	2.7	13.7	61.6	0.0	0.0	0.0	0.0
RT022171	322	28.8	3.8	0.9	8.4	13.4	40.9	32.5	0.0	0.0	0.0

Appendix 5. Summary of land use patterns within a 1 km radius buffer of the tidal creek stations sampled by the SCDNR. All values represent percent of total upland present within the buffer.

Station	Total Hectares	Total Upland Hectares	Scrub/Shrub Wetland + Forested Wetland	Bare Land	Grassland/Pasture + Scrub/Shrub	Deciduous Forest + Mixed Forest	Evergreen Forest	Cultivated Land	Urban (low)	Urban (high)	Urban (combined)
RT022282	322	183.5	13.0	0.0	15.2	8.4	44.2	0.0	6.2	12.9	19.1
RT99001	324	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RT99002	322	1.4	6.7	0.0	60.0	20.0	0.0	13.3	0.0	0.0	0.0
RT99003	323	55.8	8.1	0.0	1.8	2.1	87.6	0.0	0.5	0.0	0.5
RT99004	323	60.5	5.4	0.0	7.7	8.2	46.4	32.3	0.0	0.0	0.0
RT99005	323	157.7	0.1	0.0	0.1	4.2	75.6	0.0	18.0	2.1	20.1
RT99006	322	171.1	4.6	14.0	10.3	3.9	67.2	0.0	0.0	0.0	0.0
RT99007	323	92.8	1.1	0.2	2.7	6.0	19.7	0.2	54.9	15.2	70.1
RT99008	322	1.3	14.3	0.0	0.0	14.3	71.4	0.0	0.0	0.0	0.0
RT99009	322	195.5	1.8	0.2	17.8	10.4	66.3	3.6	0.0	0.0	0.0
RT99010	323	135.0	6.3	0.0	13.6	24.3	54.7	1.0	0.0	0.0	0.0
RT99012	322	37.0	49.4	0.0	5.4	5.6	39.7	0.0	0.0	0.0	0.0
RT99013	323	3.3	81.1	0.0	8.1	0.0	0.0	0.0	10.8	0.0	10.8
RT99017	322	248.2	3.7	0.0	0.2	5.2	32.2	0.1	53.4	5.2	58.6
RT99019	322	146.4	6.9	0.1	15.1	8.0	53.0	16.8	0.0	0.0	0.0
RT99021	323	18.0	5.0	0.0	17.0	20.5	38.0	0.0	12.5	7.0	19.5
RT99022	322	121.5	19.6	0.7	3.7	6.4	43.7	0.0	25.9	0.0	25.9
RT99024	322	68.6	5.1	0.3	10.5	9.7	73.1	1.3	0.0	0.0	0.0
RT99026	324	49.1	11.0	0.0	9.7	6.0	73.3	0.0	0.0	0.0	0.0
RT99027	324	162.1	0.1	0.0	17.4	5.9	68.2	8.3	0.0	0.0	0.0
RT99028	322	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RT99029	322	57.6	3.4	0.5	8.0	11.3	24.5	52.3	0.0	0.0	0.0
RT99030	322	118.4	1.4	0.0	3.0	2.2	84.1	0.2	7.5	1.7	9.2
RT99036	321	3.4	18.4	5.3	7.9	0.0	68.4	0.0	0.0	0.0	0.0
RT99037	322	221.4	83.0	0.0	0.3	0.3	16.4	0.0	0.0	0.0	0.0
RT99038	322	1.1	66.7	0.0	0.0	0.0	0.0	0.0	33.3	0.0	33.3
RT99039	322	48.0	6.6	0.0	22.5	5.8	58.2	6.9	0.0	0.0	0.0
RT99040	322	95.9	1.2	0.0	4.3	2.8	65.3	0.8	22.6	3.0	25.6

Appendix 6. Summary of land use patterns within a 2 km radius buffer of the open water stations sampled by the SCDNR. All values represent percent of total upland present within the buffer.

Station	Total Hectares	Total Upland Hectares	Scrub/Shrub Wetland + Forested Wetland	Bare Land	Grassland/Pasture + Scrub/Shrub	Deciduous Forest + Mixed Forest	Evergreen Forest	Cultivated Land	Urban (low)	Urban (high)	Urban (combined)
BBS2	1271	805.0	4.0	0.5	8.9	3.6	37.1	0.0	39.5	6.3	45.8
BBS3	1270	869.0	4.1	0.1	9.3	5.3	41.9	0.0	33.9	5.3	39.2
BBS4	1271	566.0	3.7	1.6	4.1	4.6	47.7	0.2	34.1	4.1	38.2
BBS5	1272	470.0	3.7	2.1	4.4	4.7	51.8	0.2	30.2	2.9	33.1
BBS6	1271	537.0	10.3	0.5	5.9	7.6	49.4	0.0	25.6	0.9	26.4
CP94082	1273	817.8	9.1	0.5	10.5	8.5	19.3	1.6	22.2	28.2	50.4
CP94KOP	1272	631.3	0.8	0.0	1.1	2.0	2.4	0.0	45.2	48.4	93.6
CP94SPY	1271	750.8	5.6	0.0	0.6	2.1	2.1	0.1	31.7	57.7	89.4
CP95150	1272	270.2	19.6	0.0	5.5	5.8	68.9	0.2	0.0	0.0	0.0
CP95151	1271	763.4	5.0	0.0	0.4	4.3	9.1	0.0	43.4	37.8	81.2
CP95152	1272	795.5	7.2	0.0	0.3	3.2	6.6	0.0	38.2	44.4	82.6
CP95154	1272	222.3	24.7	19.2	22.4	18.9	14.8	0.0	0.0	0.0	0.0
CP95156	1271	191.3	19.7	0.0	5.0	6.6	64.0	4.7	0.0	0.0	0.0
CP97082	1273	817.8	9.1	0.5	10.5	8.5	19.3	1.6	22.2	28.2	50.4
CP97156	1271	191.3	19.7	0.0	5.0	6.6	64.0	4.7	0.0	0.0	0.0
MR1-02	1272	860.3	5.8	0.5	12.6	20.9	46.4	9.7	4.1	0.1	4.2
MR1-03	1270	868.4	5.6	0.3	11.8	18.5	50.7	9.3	3.8	0.1	3.9
MR2-01	1272	691.5	4.0	0.5	2.5	13.9	41.8	0.6	32.9	3.8	36.7
MR2-02	1271	385.7	3.7	0.6	7.4	14.2	61.3	0.7	12.1	0.0	12.2
MR2-03	1271	678.8	7.0	2.4	8.8	7.8	70.2	0.8	3.0	0.0	3.0
MR3-01	1271	208.4	8.8	2.2	33.9	8.3	40.4	1.1	5.2	0.0	5.2
NO01098	1273	671.9	2.2	0.0	1.3	2.1	2.1	0.0	39.2	53.1	92.4
NO01099	1275	852.8	8.7	0.5	7.7	7.6	12.5	1.0	28.2	33.9	62.1
NO026302	1272	871.2	1.9	0.0	5.1	8.7	64.9	0.4	16.5	2.4	19.0
OBS4	1274	656.6	6.2	1.5	21.3	23.3	19.1	26.0	2.8	0.0	2.8
OBS5	1273	942.9	6.0	2.1	21.1	30.4	23.7	14.5	2.1	0.0	2.1
RO00006	1273	193.8	5.2	49.3	9.3	9.2	26.9	0.0	0.0	0.0	0.0
RO00007	1273	644.9	50.4	0.0	11.6	13.3	15.7	1.5	1.5	5.9	7.4
RO00008	1271	114.3	2.0	10.3	6.5	2.1	78.7	0.3	0.0	0.0	0.0
RO00009	1271	431.5	2.3	0.2	2.4	4.8	26.0	0.0	48.7	15.6	64.3
RO00010	1273	282.3	7.5	2.5	11.5	11.0	65.6	0.0	1.9	0.0	1.9
RO00015	1273	250.7	7.7	0.0	4.1	8.6	70.6	0.4	4.5	4.1	8.5
RO00016	1272	474.0	5.1	0.3	6.3	7.4	74.6	0.1	5.2	0.9	6.2
RO00017	1273	11.0	32.8	20.5	35.2	6.6	4.9	0.0	0.0	0.0	0.0
RO00018	1273	10.0	66.7	12.6	16.2	0.9	3.6	0.0	0.0	0.0	0.0
RO00019	1271	537.9	4.1	0.5	7.4	20.5	62.3	0.8	4.4	0.0	4.4
RO00021	1275	285.3	9.0	0.2	10.9	10.2	66.4	3.3	0.0	0.0	0.0
RO00023	1272	121.8	3.9	0.7	0.4	3.4	64.3	0.3	26.6	0.4	27.0
RO00024	1272	545.2	8.2	13.6	21.8	20.0	30.9	1.3	4.2	0.0	4.2
RO00033	1274	528.7	9.2	0.3	2.9	5.1	14.9	1.1	51.3	15.1	66.4
RO00034	1272	155.4	75.2	0.0	8.5	5.0	9.2	1.5	0.5	0.1	0.6
RO00035	1270	182.4	4.1	0.1	11.2	1.6	57.2	25.8	0.0	0.0	0.0
RO00036	1273	411.9	4.4	0.0	17.6	16.6	51.8	4.9	4.5	0.3	4.7
RO00037	1272	0.5	33.3	66.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RO00045	1271	602.8	7.9	0.3	13.5	12.1	49.6	0.9	15.2	0.4	15.6
RO00046	1273	467.8	13.0	0.0	16.2	19.1	49.4	2.3	0.0	0.0	0.0
RO00047	1274	78.3	23.1	23.4	15.6	4.1	21.4	0.0	12.3	0.0	12.3
RO00048	1274	422.1	4.8	19.5	22.4	7.1	21.1	8.6	14.2	2.4	16.6
RO00049	1271	45.3	14.5	29.8	6.8	0.4	24.1	1.6	22.9	0.0	22.9

Appendix 6. Summary of land use patterns within a 2 km radius buffer of the open water stations sampled by the SCDNR. All values represent percent of total upland present within the buffer.

Station	Total Hectares	Total Upland Hectares	Scrub/Shrub Wetland + Forested Wetland	Bare Land	Grassland/Pasture + Scrub/Shrub	Deciduous Forest + Mixed Forest	Evergreen Forest	Cultivated Land	Urban (low)	Urban (high)	Urban (combined)
RO00055	1273	79.7	13.7	67.5	14.1	1.1	3.4	0.2	0.0	0.0	0.0
RO00056	1272	840.9	3.2	0.0	0.6	2.0	2.2	0.1	32.8	59.1	92.0
RO00057	1271	721.1	2.7	0.5	16.2	9.2	54.2	9.0	7.7	0.4	8.1
RO00058	1271	234.2	4.6	0.0	21.4	18.1	46.9	8.9	0.0	0.0	0.0
RO00059	1270	769.9	3.3	1.1	5.6	4.9	47.7	0.2	33.1	4.2	37.3
RO01109	1273	754.4	35.4	0.1	13.5	10.3	23.8	8.0	4.8	4.2	9.0
RO01111	1270	89.6	3.4	0.7	5.5	10.4	57.6	0.5	19.2	2.6	21.8
RO01112	1270	284.9	6.6	2.3	2.3	4.5	32.4	0.3	41.3	10.3	51.7
RO01114	1272	1043.3	12.9	0.0	14.7	9.2	55.0	2.9	4.8	0.4	5.2
RO01115	1274	73.9	1.1	7.6	23.1	8.3	56.9	3.0	0.0	0.0	0.0
RO01116	1272	114.7	27.6	9.5	32.3	10.7	19.9	0.0	0.0	0.0	0.0
RO01117	1272	330.9	7.8	2.4	8.0	9.4	64.2	0.3	6.4	1.5	7.9
RO01121	1273	477.4	7.3	0.0	7.9	8.5	38.4	4.2	30.2	3.6	33.8
RO01122	1272	54.5	15.9	1.7	32.1	30.9	15.7	3.8	0.0	0.0	0.0
RO01124	1270	360.5	4.9	0.0	0.7	3.5	63.7	0.3	25.3	1.6	26.9
RO01125	1273	377.6	5.4	1.0	12.2	17.6	43.2	0.1	19.7	0.8	20.5
RO01129	1272	84.0	21.4	9.1	6.5	6.0	41.3	0.2	11.3	4.2	15.4
RO01130	1273	1069.6	2.5	0.5	14.7	18.6	47.8	0.1	13.9	1.9	15.8
RO01131	1271	317.7	1.8	0.1	4.7	7.1	84.1	2.2	0.0	0.0	0.0
RO01132	1271	561.9	4.5	0.1	17.0	14.7	56.9	6.2	0.5	0.1	0.6
RO01133	1273	4.4	51.0	34.7	0.0	0.0	0.0	0.0	14.3	0.0	14.3
RO01144	1273	406.1	2.1	0.6	16.5	5.6	33.4	35.3	5.0	1.5	6.4
RO01145	1273	389.3	3.1	0.5	6.9	6.6	64.5	3.2	14.5	0.7	15.2
RO01146	1272	234.0	16.7	16.2	18.6	7.2	31.9	0.0	9.3	0.0	9.3
RO01147	1272	479.8	3.0	1.6	8.5	6.8	52.3	1.4	22.6	3.8	26.4
RO01148	1274	37.9	11.6	6.7	28.7	13.8	20.9	0.0	10.0	8.3	18.3
RO01161	1273	386.1	10.7	0.2	12.8	11.8	56.0	6.5	2.0	0.0	2.0
RO01162	1272	210.4	3.0	0.0	10.6	4.3	78.6	0.1	1.8	1.6	3.4
RO01164	1273	293.9	3.8	0.0	3.1	5.0	42.1	0.4	40.2	5.5	45.7
RO01165	1271	114.8	18.6	4.5	1.7	7.1	43.3	0.0	24.8	0.0	24.8
RO026001	1273	18.7	39.9	36.5	15.4	1.9	6.3	0.0	0.0	0.0	0.0
RO026002	1273	75.0	8.0	1.3	17.3	2.7	65.3	1.3	4.0	0.0	4.0
RO026003	1272	568.6	0.5	0.0	0.9	5.7	60.1	1.1	24.7	7.0	31.7
RO026006	1272	320.5	18.3	3.2	6.0	3.1	56.9	0.1	12.2	0.2	12.4
RO026007	1271	403.6	2.6	0.0	0.0	2.2	83.1	0.0	12.0	0.1	12.1
RO026008	1271	0.4	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RO026009	1272	480.4	6.4	7.9	20.2	10.3	40.4	0.0	13.7	1.1	14.8
RO026010	1272	530.8	5.3	0.3	5.7	10.0	78.3	0.3	0.0	0.0	0.0
RO026011	1271	176.7	48.1	18.6	11.5	5.2	11.5	0.0	5.0	0.0	5.0
RO026012	1275	324.4	11.0	0.4	15.2	14.2	20.3	3.6	21.9	13.4	35.3
RO026013	1271	191.2	2.4	0.7	3.2	4.5	31.9	57.3	0.0	0.0	0.0
RO026014	1271	731.4	0.3	0.0	4.9	5.9	74.8	0.1	8.9	5.1	14.0
RO026016	1272	210.8	9.1	3.6	2.9	6.2	52.9	0.2	23.3	1.8	25.1
RO026017	1273	416.3	3.2	0.3	0.7	8.8	55.7	0.1	26.3	4.8	31.1
RO026019	1272	227.6	7.2	0.0	10.5	22.2	59.4	0.7	0.0	0.0	0.0
RO026020	1273	246.4	4.7	2.0	1.7	4.7	43.4	0.0	34.8	8.7	43.5
RO026021	1273	242.8	21.7	4.1	14.7	12.2	39.1	0.6	7.7	0.0	7.7
RO026022	1273	102.4	13.7	4.2	3.4	2.9	73.2	0.0	2.5	0.0	2.5
RO026023	1271	436.8	5.7	10.6	23.6	22.0	34.7	1.0	2.5	0.0	2.5

Appendix 6. Summary of land use patterns within a 2 km radius buffer of the open water stations sampled by the SCDNR. All values represent percent of total upland present within the buffer.

Station	Total Hectares	Total Upland Hectares	Scrub/Shrub Wetland + Forested Wetland	Bare Land	Grassland/Pasture + Scrub/Shrub	Deciduous Forest + Mixed Forest	Evergreen Forest	Cultivated Land	Urban (low)	Urban (high)	Urban (combined)
RO026024	1272	957.7	2.3	1.7	22.6	17.0	45.1	0.1	10.3	0.9	11.2
RO026025	1272	32.5	8.9	8.6	24.4	5.0	52.6	0.6	0.0	0.0	0.0
RO026026	1272	180.2	7.2	5.1	3.1	4.3	10.9	1.8	59.1	8.4	67.5
RO026027	1274	10.7	33.6	20.2	34.5	6.7	5.0	0.0	0.0	0.0	0.0
RO026028	1272	744.7	2.5	0.0	16.7	4.6	1.2	0.0	29.0	45.9	74.9
RO026029	1273	144.6	45.7	0.0	22.2	14.1	16.6	1.3	0.0	0.0	0.0
RO026030	1272	577.8	0.5	0.0	0.7	1.8	6.0	0.0	49.1	41.8	90.9
RO026151	1271	121.7	9.8	0.0	8.1	16.5	65.6	0.0	0.0	0.0	0.0
RO026290	1272	651.4	10.1	0.0	17.2	11.1	15.8	10.3	20.3	15.2	35.5
RO99301	1271	490.6	1.3	0.0	20.9	7.0	68.5	2.3	0.0	0.0	0.0
RO99302	1272	486.7	19.5	0.0	17.9	13.4	46.2	3.0	0.0	0.0	0.0
RO99303	1272	248.5	7.2	7.4	7.0	6.2	48.6	0.3	14.6	8.7	23.4
RO99304	1271	928.0	6.4	1.7	21.8	31.5	20.4	16.4	1.8	0.0	1.8
RO99305	1270	56.0	18.5	23.3	5.8	0.3	29.1	2.4	20.6	0.0	20.6
RO99306	1273	215.4	0.8	55.0	3.3	3.7	11.4	0.1	21.1	4.6	25.8
RO99307	1273	817.1	30.5	0.0	16.2	17.7	35.1	0.4	0.0	0.0	0.0
RO99309	1273	442.2	3.4	0.0	0.4	3.3	69.4	0.3	22.0	1.1	23.1
RO99310	1273	112.3	11.0	17.5	10.3	2.9	36.5	0.0	20.5	1.4	21.9
RO99311	1275	145.4	16.6	3.2	22.3	8.7	49.3	0.0	0.0	0.0	0.0
RO99312	1273	434.4	4.6	0.1	11.5	9.8	54.7	9.9	9.2	0.3	9.4
RO99313	1271	645.7	5.7	0.1	14.9	16.9	36.2	8.7	15.2	2.4	17.6
RO99315	1270	969.1	4.0	0.5	6.5	18.2	61.9	7.6	1.3	0.0	1.3
RO99317	1272	150.8	11.0	30.8	6.5	7.9	43.7	0.0	0.0	0.0	0.0
RO99318	1272	145.9	1.6	6.8	3.8	1.0	86.6	0.1	0.0	0.0	0.0
RO99319	1273	119.0	4.5	0.8	10.4	3.0	47.9	1.1	29.4	3.0	32.4
RO99320	1273	185.0	5.9	0.5	22.7	3.8	64.3	0.5	2.2	0.0	2.2
RO99322	1272	533.9	16.0	0.0	1.7	3.7	8.9	0.2	44.0	25.5	69.5
RO99323	1274	136.4	1.0	0.2	6.7	6.1	69.4	16.6	0.0	0.0	0.0
RO99324	1273	312.5	18.0	1.1	19.5	23.8	33.5	0.3	3.6	0.0	3.6
RO99325	1272	297.5	5.1	6.0	29.8	16.3	38.3	1.5	3.1	0.0	3.1
RO99327	1271	706.1	3.9	0.3	29.6	10.1	46.4	3.0	3.8	2.9	6.6
RO99328	1272	44.3	1.4	2.2	3.9	2.6	89.8	0.0	0.0	0.0	0.0
RO99329	1272	429.8	0.9	0.0	2.4	4.6	37.5	2.7	35.6	16.2	51.8
RO99330	1271	859.0	4.3	0.1	13.2	4.4	42.0	0.0	31.4	4.5	36.0

Appendix 7. Mean value of environmental conditions measured among tidal creek stations sampled in the 30 Hydrologic Unit Codes (HUCs). N represents the number of stations sampled to provide the mean.

HUC	Dissolved Oxygen (ppm)		pH		Salinity (ppt)		Total Organic Carbon - Water (mg/L)		Biochemical Oxygen Demand (mg/L)		Total Nitrogen (mg/L)		Total Phosphorus (mg/L)		Chlorophyll a (mg/L)		Fecal Coliform (col./100mL)		Silt/Clay (%)		Total Organic Carbon - Sediment (mg/L)		Effects Range Median-Quotient (ERMQ)	
	$\bar{x}$	N	$\bar{x}$	N	$\bar{x}$	N	$\bar{x}$	N	$\bar{x}$	N	$\bar{x}$	N	$\bar{x}$	N	$\bar{x}$	N	$\bar{x}$	N	$\bar{x}$	N	$\bar{x}$	N	$\bar{x}$	N
03050202070020	3.11	2	7.58	2	28.35	2	4.95	2	2.30	2	0.59	2	0.07	2	12.50	2	940.50	2	49.86	2	2.46	2	0.064	2
03050202040020	3.43	1	7.57	1	18.27	1	9.60	1	0.00	1	0.72	1	0.30	1	14.20	1	50.00	1	92.05	1	7.60	1	0.226	1
03050208090070	4.50	2	7.35	2	30.85	2	6.40	2	0.65	2	0.45	2	0.08	2	13.11	2	6.50	2	15.69	2	0.69	2	0.009	2
03050201080020	3.01	4	7.18	4	21.50	4	5.38	4	2.60	4	0.59	3	0.06	4	17.72	4	84.00	4	11.70	4	0.47	4	0.009	4
03050208010070	3.43	4	7.24	4	28.95	4	10.45	4	0.00	4	0.80	4	0.16	4	8.25	4	45.00	4	24.77	4	0.90	4	0.007	4
03050201050020	4.21	3	7.43	3	13.98	3	4.83	3	1.03	3	0.59	3	0.06	3	12.77	3	60.00	3	33.08	3	1.55	3	0.032	3
03050208110040	4.19	3	7.47	3	29.69	3	15.27	3	2.93	3	0.60	3	0.14	3	19.57	3	53.33	3	17.84	3	0.66	3	0.010	3
03050208090100	4.74	5	7.34	5	31.05	5	6.10	5	1.74	5	0.76	5	0.10	5	26.74	5	38.60	5	18.21	5	0.53	5	0.022	5
03050208090060	4.99	4	7.62	4	31.67	4	6.85	4	1.38	4	0.63	4	0.11	4	13.61	4	13.25	4	50.09	4	2.12	4	0.021	4
03040207020160	4.46	3	7.68	3	32.67	3	2.60	3	1.87	3	0.52	2	0.09	3	11.23	3	27.00	3	4.09	3	0.10	3	0.005	3
03050205070030	3.83	8	7.36	8	22.97	8	4.10	3	1.84	8	0.73	4	0.08	4	17.19	8	74.63	8	44.24	8	2.53	8	0.018	8
03040207040020	4.62	2	7.77	2	34.79	2	2.00	2	2.15	2	0.49	1	0.07	1	7.49	2	2.50	2	4.38	2	0.07	2	0.005	2
03050208100020	4.20	4	7.34	4	31.56	4	6.78	4	2.08	4	0.78	2	0.11	3	15.51	4	26.25	4	42.19	4	1.54	4	0.017	4
03050208110030	4.68	4	7.47	4	31.79	4	4.30	1	0.00	1		0	0.07	1	16.80	1	22.00	1	11.86	4	0.29	4	0.003	4
03040207020200	5.41	2	7.77	2	36.16	2	1.15	2	3.35	2	0.38	1	0.05	1	6.05	2	12.00	2	12.07	2	0.35	2	0.004	2
03050208100050	4.14	2	7.55	2	30.55	2	0.00	2	4.90	2	0.70	2	0.11	2	16.93	2	10.50	2	20.39	2	0.43	2	0.011	2
03050208100060	3.99	12	7.53	12	34.96	12	3.32	9	1.15	12	0.48	10	0.08	12	8.18	12	3.00	12	28.06	12	0.84	12	0.012	12
03050202070040	4.36	5	7.58	5	33.68	5	4.08	5	1.40	5	0.73	4	0.10	4	13.34	5	26.60	5	13.76	5	0.43	5	0.013	6
03050202060010	3.62	8	7.44	8	34.14	8	1.86	8	0.69	8	0.75	7	0.07	6	12.94	8	3.13	8	61.78	8	2.79	8	0.028	8
03050202070030	3.94	7	7.64	7	34.63	7	2.73	7	0.99	7	0.46	5	0.07	5	10.61	7	10.86	7	23.22	7	0.72	7	0.015	7
03050208100010	3.26	4	7.56	4	34.77	4	5.93	4	1.52	4	0.28	2	0.06	2	13.46	4	12.50	4	29.35	4	0.79	4	0.011	4
03050205070040	3.86	3	7.50	3	30.75	3	2.33	3	0.37	3	0.57	3	0.08	3	11.40	3	13.33	3	18.24	3	0.74	3	0.030	4

Appendix 8. Mean value of environmental conditions measured among open water stations sampled in the 30 Hydrologic Unit Codes (HUCs). N represents the number of stations sampled to provide the mean.

HUC	Dissolved Oxygen (ppm)		pH		Salinity (ppt)		Total Organic Carbon - Water (mg/L)		Biochemical Oxygen Demand (mg/L)		Total Nitrogen (mg/L)		Total Phosphorus (mg/L)		Chlorophyll a (ug/L)		Fecal Coliform (col./100mL)		Silt/Clay (%)		Total Organic Carbon - Sediment (mg/L)		Effects Range Median-Quotient (ERMQ)	
	$\bar{X}$	N	$\bar{X}$	N	$\bar{X}$	N	$\bar{X}$	N	$\bar{X}$	N	$\bar{X}$	N	$\bar{X}$	N	$\bar{X}$	N	$\bar{X}$	N	$\bar{X}$	N	$\bar{X}$	N	$\bar{X}$	N
03040207030060	5.25	3	6.89	3	7.09	3	11.00	1	0.00	1	1.09	1	0.07	1	14.00	1	70.00	1	92.52	3	5.70	3	0.108	3
03050112060030	5.44	2	7.38	2	22.33	2	4.95	2	0.00	2	0.55	2	0.03	2	19.56	2	21.50	2	21.08	2	0.75	2	0.009	2
03050208040010	3.83	2	7.19	2	15.62	2	8.80	2	0.95	2	0.94	2	0.10	2	9.94	2	11.50	2	49.78	2	3.36	2	0.019	2
03050201050020	5.34	4	7.81	4	19.22	4	3.45	4	0.83	4	0.43	4	0.04	4	6.23	4	66.75	4	50.13	4	2.20	4	0.123	5
03040207020130	5.52	2	7.64	2	18.41	2	9.05	2	1.05	2	0.80	1	0.06	2	11.14	2	110.50	2	27.42	2	0.85	2	0.015	2
03040207040040	4.68	3	7.35	3	13.07	3	11.13	3	1.80	3	0.84	3	0.12	3	19.88	3	10.00	3	57.62	3	4.39	3	0.048	3
03040207040020	4.64	2	7.42	2	25.97	2	4.95	2	2.55	2	0.48	2	0.04	2	14.90	2	3.00	2	5.98	2	0.31	2	0.002	2
03050205070030	4.65	3	7.62	3	31.39	3	3.65	2	0.00	3	0.53	1	0.07	1	7.76	3	14.33	3	39.55	3	2.00	3	0.025	3
03050202060010	5.36	2	7.70	2	34.92	2	4.20	2	1.20	2	0.42	2	0.06	2	13.41	2	1.00	2	31.67	2	1.41	2	0.016	2
03050202040020	5.56	4	7.61	4	23.82	4	6.50	2	1.20	2	0.46	2	0.12	2	21.10	2	25.00	2	57.54	4	1.84	4	0.245	5
03050208100020	4.25	6	7.49	6	29.64	6	4.80	6	1.30	6	0.38	4	0.09	5	8.26	6	1.33	6	10.32	6	0.28	6	0.007	6
03050208110040	4.54	7	7.49	7	29.40	7	30.73	7	1.50	7	0.48	7	0.11	7	15.41	7	261.29	7	9.26	7	0.29	7	0.010	7
03050205070040	4.14	3	7.45	3	31.30	3	3.00	2	1.10	3	0.71	2	0.03	2	9.09	3	15.67	3	7.14	3	0.26	3	0.008	3
03040207020200	4.61	1	7.90	1	36.23	1		0	1.30	1		0	0.13	1	8.17	1	14.00	1	2.55	1	0.05	1	0.005	1
03050202070040	4.87	2	7.75	2	31.37	2	1.50	2	1.05	2	0.00	2	0.09	2	9.14	2	1.00	2	15.65	2	0.73	2	0.011	2
03050201080020	4.42	4	7.48	4	22.79	4	6.10	4	0.40	4	0.45	4	0.04	3	11.77	4	3.50	4	6.65	4	0.28	4	0.007	4
03050208010070	4.34	1	7.60	1	36.40	1	4.30	1	0.00	1	0.31	1	0.05	1	6.95	1	0.00	1	4.15	1	0.11	1	0.004	1
03050208090060	4.25	2	7.44	2	33.21	2	4.25	2	0.00	2	0.43	2	0.08	2	7.23	2	2.00	2	17.62	2	0.56	2	0.015	2
03040207040030	4.19	1	7.70	1	12.63	1	10.00	1	0.00	1	0.59	1	0.05	1	16.77	1	70.00	1	4.35	1	0.38	1	0.003	1
03050208100060	4.89	2	7.69	2	35.03	2	4.05	2	1.40	2	0.45	2	0.09	2	10.77	2	0.00	2	20.35	2	0.60	2	0.010	2
03050208110030	4.76	10	7.56	10	29.95	10	2.25	4	1.65	4	0.43	4	0.05	4	10.83	4	3.75	4	13.82	10	0.32	10	0.008	10
03050208090070	5.24	4	7.59	4	33.69	4	4.10	4	0.50	4	0.51	3	0.07	3	7.44	4	1.00	4	3.54	4	0.13	4	0.007	4
03050208090100	4.28	7	7.45	7	30.29	7	3.59	7	1.94	7	0.55	6	0.07	6	8.24	7	3.50	4	17.24	7	0.57	7	0.014	7
03050202070030	5.66	3	7.80	3	28.01	3	3.80	2	0.00	2	0.26	2	0.05	2	6.34	2	13.50	2	26.23	3	0.80	3	0.026	3
03050208100010	4.22	4	7.51	4	31.46	4	7.07	4	0.90	4	0.40	4	0.08	4	6.65	4	1.50	4	12.25	4	0.49	4	0.010	4
03050208100050	4.81	8	7.66	8	33.21	8	2.43	7	0.86	8	0.59	7	0.07	8	7.74	8	3.50	8	10.66	8	0.27	8	0.007	8
03050202070020	6.06	2	8.00	2	28.24	2	3.25	2	0.00	2	0.28	2	0.05	2	8.09	2	0.00	2	8.63	2	0.27	2	0.007	2
03050205060070	4.39	1	7.60	1	33.00	1	2.40	1	1.00	1	0.62	1	0.10	1	11.63	1	0.00	1	22.80	1	0.90	1	0.011	1